FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

First Aeronautical Weekly in the World. Founded January, 1909

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice and Progress of Aerial Locomotion and Transport

OFFICIAL ORGAN OF THE ROYAL AERO CLUB OF THE UNITED KINGDOM

No. 1113. (Vol. XXII. No. 17.) April 25, 1930 **Weekly, Price 6d. Post free, 7½d. Abroad, 8d.**

Editorial Offices: 36, GREAT QUEEN STREET, KINGSWAY, W.C.2.
Telephone: Editorial, Holborn 1884. Advertising, Holborn 3211
Telegrams: Truditur, Westcent. London.

Annual Subscription Rates, Post Free.
United Kingdom .. 30*s.* 4*d.* Abroad .. .. 33*s.* 0*d.**

* *Foreign subscriptions must be remitted in British currency. (See last Editorial Page.)*

CONTENTS

DIARY OF CURRENT AND FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in this list—

1930	
April 26	45 Sq. (R.A.F.) Reunion Dinner at "Crown and Cushion," London Wall, E.C.
May 2	A.I.D., T.S.A. Dinner at Hotel Russell.
May 10	N.F.S. Air Meeting, Leeds.
May 17	Flying Display and Opening of Brooklands Aero Club.
May 31	Official Opening and Air Pageant, Bristol Airport.
June 7	N.F.S. Air Meeting, Reading.
June 9	Northampton Flying Meeting.
June 14	Manston Garden Party.
June 15	N.F.S. Air Meeting, Nottingham.
June 19	Household Brigade Flying Club Meeting at Heston.
June 21	Air Rallye at Haldon Aerodrome, Teignmouth.
June 26	Ipswich Air Pageant.
June 27	R.A.F. Dinner Club Annual Dinner.
June 28	Royal Air Force Display, Hendon.
July 5	King's Cup Race and Hanworth Air Pageant.
July 13	N.F.S. Flying Meeting, Leeds.
July 19	N.F.S. Flying Meeting, Hull.
July 20-Aug. 7	International Light 'Plane Tour of Europe, starting from Berlin.
July 26	Norwich Flying Meeting.
July 31	Entries close for 1931 Schneider Trophy Contest.
Sept. 1-6	5th International Air Congress at The Hague.
Sept. 6-28	Aero Exhibition, Stockholm, Sweden.
Sept. 20	Liverpool Air Pageant.
Sept. 27	N.F.S. Air Meeting, Hanworth.
Nov. 28-Dec. 14	Paris Aero Show.
Dec. 31	Closing date for the Aga Khan's Prize for Indian Flight.

EDITORIAL COMMENT

ACCORDING to the Paris correspondent of *The Times*, the French Government has decided to encourage private flying and the private ownership of aeroplanes by instituting a scheme of subsidies, particulars of which are given in *The Times* of April 22. As the French subsidy is established on a basis quite different from that upon which subsidies are paid to light aeroplane clubs in this country, an examination of the French scheme, as set out, is interesting.

The French Way

Aircraft being still expensive, and running costs and repairs amounting to considerable sums, the French Government has, in fact, decided to contribute something like one-half of the expense, so that in the future the French owner of a light 'plane will be in clover as compared with his British opposite number. Already our French friends are very interested in and proud of their aviation, and it is not to be doubted that the new subsidy scheme will result in giving practical expression to French "air-mindedness." It is somewhat peculiar that this step should happen to be taken by the French Government at a time when our own Government is undecided as to whether or how the British private owner is to be helped or otherwise. The average member of a light aeroplane club has not over-great chances of becoming a private owner, and the future of the clubs themselves does not appear any too secure.

Briefly the French scheme provides for an initial grant towards the purchase price of a machine, grants for each seat in the machine, grants for engine power (between 40 and 100), grants for safety devices, allowances for maintenance, and grants for metal construction. Firstly, an initial grant towards purchase price will be made, this grant amounting to 8,000 francs for all types of machine. Then there will be a State contribution of 10,000 francs for the first seat, and 12,000 francs for the second and third seats, a condition being that machines must have a cruising range of not

less than 300 km. in the case of landplanes, and 150 km. for seaplanes and amphibians.

Subsidies will also be paid on a basis of engine power, within the range of 40 to 100 h.p. From 40 to 60 h.p. an allowance of 100 francs per h.p. will be made, and from 60 to 100 h.p. the allowance is increased to 200 francs per h.p. In order to encourage safety, grants will be made for parachutes, improved undercarriages (and, one supposes, slots or other means of preventing spinning) up to a maximum of 7,000 francs. By way of assisting the private owner with his running and maintenance costs, grants will be made on a basis of flying hours, the allowances ranging from 65 francs to 160 francs per hour from 100 to 250 hours. And finally subsidies up to a maximum of 6,000 francs will be paid for metal construction.

Altogether the French private owner of the near future will be in the happy position of being able to get and run a machine worth something like £750 for the equivalent of approximately £400. It is difficult to foresee the extent of the fillip which will thus be given to French private flying, but that it will result in very large numbers of machines being built and purchased is not to be doubted for a moment.

❖ ❖ ❖

The British Way

On this side of the Channel the prospects are not quite as rosy. But, on the other hand, our advertising columns this week contain an announcement which cannot fail to bring joy to the hearts of many present or prospective private owners. The De Havilland Aircraft Company announces very substantial price reductions for their "Gipsy Moths," partly as a result of improved manufacturing methods evolved during real quantity production, and partly made possible by dividing the "Gipsy Moth" into two distinct classes, to be known as the *Standard* and the *Special*, respectively. While the reduction in price cannot, needless to say, compare with the low figure which the French private owner will, with Government subsidies, enjoy, there is this to be said for the British situation, that it is an economically sound business proposition, while subsidies cannot, except indirectly, contribute towards a *real* reduction in cost. By granting subsidies the French Government will doubtless hasten the quantity production of machines and thereby enable French constructors to build more cheaply, but this effect will be national only, and is hardly likely to assist materially the French aircraft constructor where world markets are concerned.

Under the new De Havilland scheme, a *Standard* "Gipsy Moth" can be bought for £595 instead of £675. The standard machine will be of wood construction, and will be fitted with the "Gipsy I" engine of 100 h.p. The *Special* model will be of mixed construction, *i.e.*, with welded steel tube fuselage and wooden wings, and will be obtainable with either the 100 h.p. "Gipsy I" or with the 120 h.p. "Gipsy II" engine, the new prices being £675 instead of £700 and, with the more powerful engine, £750. In the *Standard* model the colour scheme will be standard, and so will the equipment. In the two *Special* models special colour schemes to suit individual tastes will be supplied, and there is a considerable range of optional equipment.

Similar price reductions are announced for the seaplane versions of the "Gipsy Moth." The De Havilland Aircraft Company can be said to have been built up almost entirely on the production of the "Moth," and the fact that they are now in a position to announce such substantial price reductions is a proof that the firm not only has produced a type of aircraft which has attained world-wide popularity, but that in doing so it has worked on lines which are commercially sound. This fact augurs well for the future of the company, and that De Havillands are not content with producing the two types of machines to which we have referred is proved by the putting into production of the new "Moth Three" which we describe in detail and illustrate in the present issue. That machine will be more expensive, but, on the other hand, it has a higher performance, and can be used as an occasional three-seater.

THE DUCHESS OF BEDFORD'S RECORD FLIGHT TO AFRICA

England—Cape Town in Ten Days

THE Duchess of Bedford has accomplished a remarkable record flight by flying, in her Fokker monoplane *Spider* (Bristol "Jupiter"), piloted by Capt. C. D. Barnard and Mr. R. Little, from England to Cape Town in ten days—having left Lympne on April 10 and reached Cape Town on April 19. The progress of the flight may briefly be summarised as follows. April 10.—Lympne-Oran, a distance of 1,300 miles, the longest trip of the flight, accomplished in 13 hours. April 11.—Tunis. April 12.—Benghazi. April 13.—Assiut. April 14.—Khartoum. April 15.—Juba. April 16.—Dodma. April 17.—Broken Hill. April 18.—Bulawayo. April 19.—Cape Town.

This last section of 1,250 miles was the longest non-stop flight yet made in South Africa. From Broken Hill very bad weather was experienced, especially just before Bulawayo; they were unable to see the Victoria Falls owing to thick clouds and rain, and lost their way. Capt. Barnard, in fact, was deciding to land, when they spotted the railway, which they followed into Bulawayo.

During the early stages of the flight they flew at from 6,000 to 9,000 ft., but as soon as they entered the tropics heavy rains were encountered and they had to fly low, sometimes just skimming the tree-tops. Incidentally, this enabled the Duchess to see a great deal of Central Africa at close quarters, and on several occasions excellent views of wild animals—lions, elephants and giraffes—which scurried away when they heard the roar of the engine. Now and again the Duchess took over the controls during the flight.

On arriving at Maitland aerodrome, only a few people greeted the Duchess—who was presented with a posy of Cape flowers—as it was wrongly announced that a landing would be made at Wynberg aerodrome. A large number of congratulatory messages awaited the Duchess.

The 9,000 miles of the outward journey was accomplished in 100 flying hours. The Fokker monoplane *Spider* was the same machine used by the Duchess on her India flight, and it was fitted with Arens controls, which functioned faultlessly throughout, while K.L.G. plugs and Shell oil and fuel were used.

On April 21, the return journey started, Maitland aerodrome being left at dawn and Broken Hill reached on April 22.

The route to be followed this time will be the same as far as Assiut, whence they will fly via Aleppo and Sofia—reducing the total distance to 8,300 miles.

THE "MOTH THREE"

Latest De Havilland Machine has High Performance

SUPERFICIALLY there is nothing to indicate that the "Moth Three" monoplane with inverted "Gipsy" engine compares in aerodynamic efficiency with the little "Tiger Moth" produced by the De Havilland Company some years ago. The "Tiger Moth" was an out-and-out racer, with the pilot's head streamlined into the fuselage with extreme care, with the monoplane wing braced entirely by streamline wires, and with an undercarriage reduced to its most compact form, with the springing buried inside the wheels. The "Moth Three," on the other hand, is a cabin monoplane, with the steeply-sloping windscreen usually associated with machines of the *conduite interieure* type, with strut-bracing of the wing, and with a more or less orthodox undercarriage in which the strut lengths have certainly not been markedly reduced, rather lengthened. At any rate, the compression legs are quite long, being anchored to the top longerons of the fuselage. And yet, in spite of all this, the machine comes within measurable distance of the little "Tiger Moth" in the matter of minimum drag coefficient. Put in another way, the "Moth Three" is a very good approach towards Professor Melvill Jones' ideal streamline aeroplane.

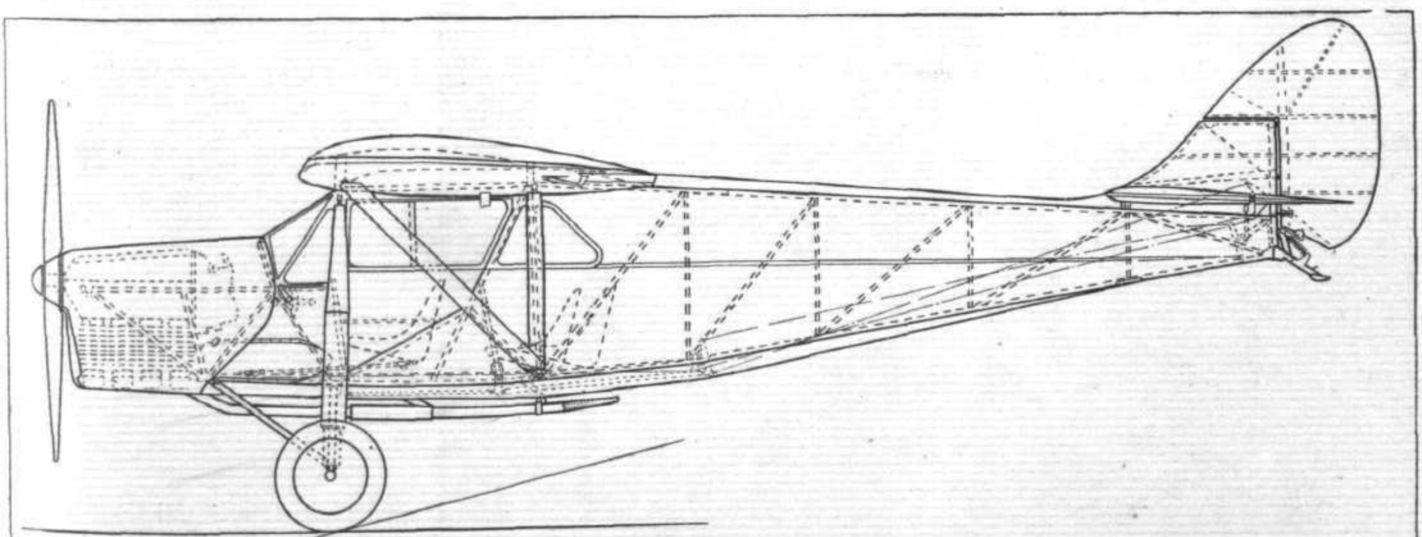
Mr. C. C. Walker, of the De Havilland Aircraft Company, has coined the expression "centresectionitis" for the evil effects which the presence of a fuselage in the centre of a wing may have on the aerodynamic efficiency of the latter. It would appear that in the "Moth Three" this affliction has been very greatly reduced, and yet there is no very obvious reason why this should be so. The two wing-halves stop short at the top longerons, the inner ends of the wings being slightly sloped down

THE DE HAVILLAND "MOTH THREE"

"Gipsy III" Engine

Length o.a.	25 *ft.* 0 *in.* (7·62 *m.*).
Wing span	36 *ft.* 9 *in.* (11·2 *m.*).
Width, folded	13 *ft.* 0 *in.* (3·96 *m.*).
Wing chord	6 *ft.* 6*in.* (1·98 *m.*).
Wing area	222 *sq. ft.* (20·6 *sq. m.*).
Tare Weight	1,150 *lb.* (523 *kg.*).
Fuel and Oil	178 *lb.* (81 *kg.*).
Useful Load	572 *lb.* (260 *kg.*).
Gross Weight	1,900 *lb.* (864 *kg.*).
Wing Loading	8·56 *lb./sq. ft.* (42 *kg./m.²*).
Power Loading (*on max. power*)	15·8 *lb./h.p.* (7·2 *kg./CV.*).
Maximum Speed ..	125 *m.p.h.* (201 *km./h.*).
Cruising Speed ..	105 *m.p.h.* (169 *km./h.*).
Stalling Speed	48 *m.p.h.* (77 *km./h.*).
Rate of Climb (*initial*) ..	660 *ft./min.* (3·35 *m./sec.*).
Service Ceiling	13,000 *ft.* (4,000 *m.*).
Range (*cruising*) ..	440 *miles* (710 *km.*).*

* *With small tanks. Two alternative tankages are available, giving ranges of* 570 *miles* (920 *km.*) *and* 700 *miles* (1,130 *km.*), *respectively.*



THE "MOTH THREE": Side elevation, showing main parts of structure.

THE "MOTH THREE": **Three-quarter front view.** (FLIGHT *Photo.*)

towards the fuselage top, which at this point consists of a transparent panel or skylight. Exactly why this arrangement should be better, aerodynamically, than one in which the wing is continued across the top of the fuselage is not at all clear. That it *is* better seems to be a fact. What may possibly also contribute towards the efficiency of the "Moth Three" is the fact that the wing span is relatively large in proportion to the cross-sectional area of the fuselage, without, however, being as large in proportion as was the span of the Fairey long-distance monoplane. The latter, it may be recollected, was stated by Mr. Fairey to have a maximum L/D of 15. What is the value of this ratio in the "Moth Three" we have no means of knowing. Our opinion that the machine is a very efficient one is based not upon a knowledge of the maximum L/D but upon the minimum drag coefficient, estimated from Professor Everling's "High-speed Figure." This is not the place to explain the derivation of this figure, and for such explanation readers are referred to the original article by Professor Everling, published in THE AIRCRAFT ENGINEER (Monthly technical supplement to FLIGHT) of November 25, 1926, and to the comments thereon by Mr. Mettam of Westland's Technical Staff in THE AIRCRAFT ENGINEER of February 24, 1927.

In British units the Everling "High-speed Figure" is

$$\frac{\eta}{2k_D} = \frac{V^3}{147{,}000} \times \frac{S}{H.P.}$$

where V is expressed in m.p.h. and S is the wing area in square feet. The "High-speed Figure," it will be seen, is, when so expressed, the propeller efficiency divided by twice the drag coefficient. As the top speed is used in computing the figure, the drag coefficient obtained is that corresponding to maximum speed, *i.e.*, the minimum drag coefficient. For the "Tiger Moth" this figure was about 26. The "Moth Three," with a maximum horsepower of 120, a top speed of 125 m.p.h., and a wing area of 222 sq. ft., it works out at 25·2. It is not, of course, certain that the propeller efficiencies of the two machines are the same, and so a very exact comparison cannot be made, but the difference cannot in any case be very great, and the difference between the two $k_D$min. coefficients cannot be very great either.

We have gone into this subject at some length because the fact that the drag of the "Moth Three" is unusually low might otherwise easily be overlooked. It is very natural to jump to the conclusion that, as the "Moth Three" has a good deal more maximum power than the ordinary "Gipsy Moth," the increase in speed is mainly due to this fact. It is partly due to the extra power, of course, but by no means entirely. That this is so might also be deduced from the fact that the increase in power is about 20 per cent., and the increase in speed about 25 per cent.

THE "MOTH THREE": **Note the starboard door open, and the air brake "on."** (FLIGHT *Photo.*)

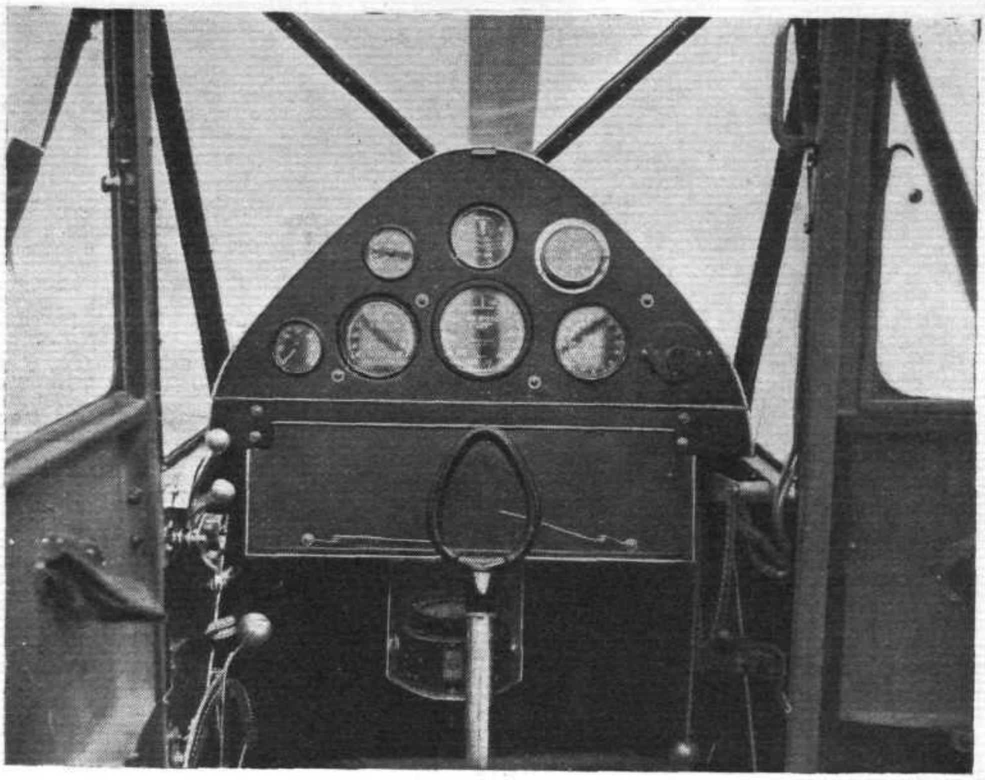
Constructional Features

Structurally the "Moth Three" resembles the well-known "Gipsy Moth" with metal fuselage in that it has a welded-steel tube fuselage

and wooden wings, although the fact that the machine is a monoplane has naturally resulted in the wing construction being slightly different. The De Havilland version of welded steel-tube construction is rather different from what one has become accustomed to.

Generally speaking, square-section tube is used for longerons and struts in the forward portion, and circular-section tube in the rear. The structure is built up as a girder, without the use of wire bracing, the bracing struts running diagonally from corner to corner in the rectangular panels.

Although the struts, horizontal as well as vertical, are welded to the tubular longerons, the welded joints are not relied upon for taking tensile stresses. Where one or more struts meet a longeron, a thin mild-steel plate digitally shaped to follow the lines of longeron and struts is pinned and welded both to the longeron and to the struts. Thus, each fuselage joint is strengthened against tensile stresses. The fuselage covering is fabric, and in order to prevent it from touching the struts, light fore-and-aft stringers are attached to the struts.



THE "MOTH THREE": View of the very neat instrument board (Smith's) and, below it, the sloping map table. On the left is the tail trimming gear, and on the right the lever which operates the air brake. (FLIGHT *Photo.*)

The fuselage is built in two halves, a bolted joint occurring in each of the four longerons just aft of the cabin. Each side is perfectly flat so that it can be assembled on a flat jig, the top and bottom bracing struts being welded in afterwards when the complete fuselage is being erected. This arrangement results in a sudden change of direction of the fuselage side aft of the cabin, but the longitudinal, fabric-carrying stringers turn this sudden change into a gradual one as far as the centre-line of each side is concerned.

At the forward end the lower longerons project some distance ahead of the cabin, while the top longerons are dropped nearly 2 ft. so as to provide the forward view from the cabin. The top longerons themselves act as engine bearers, and carry trunnion supports for the feet of the engine.

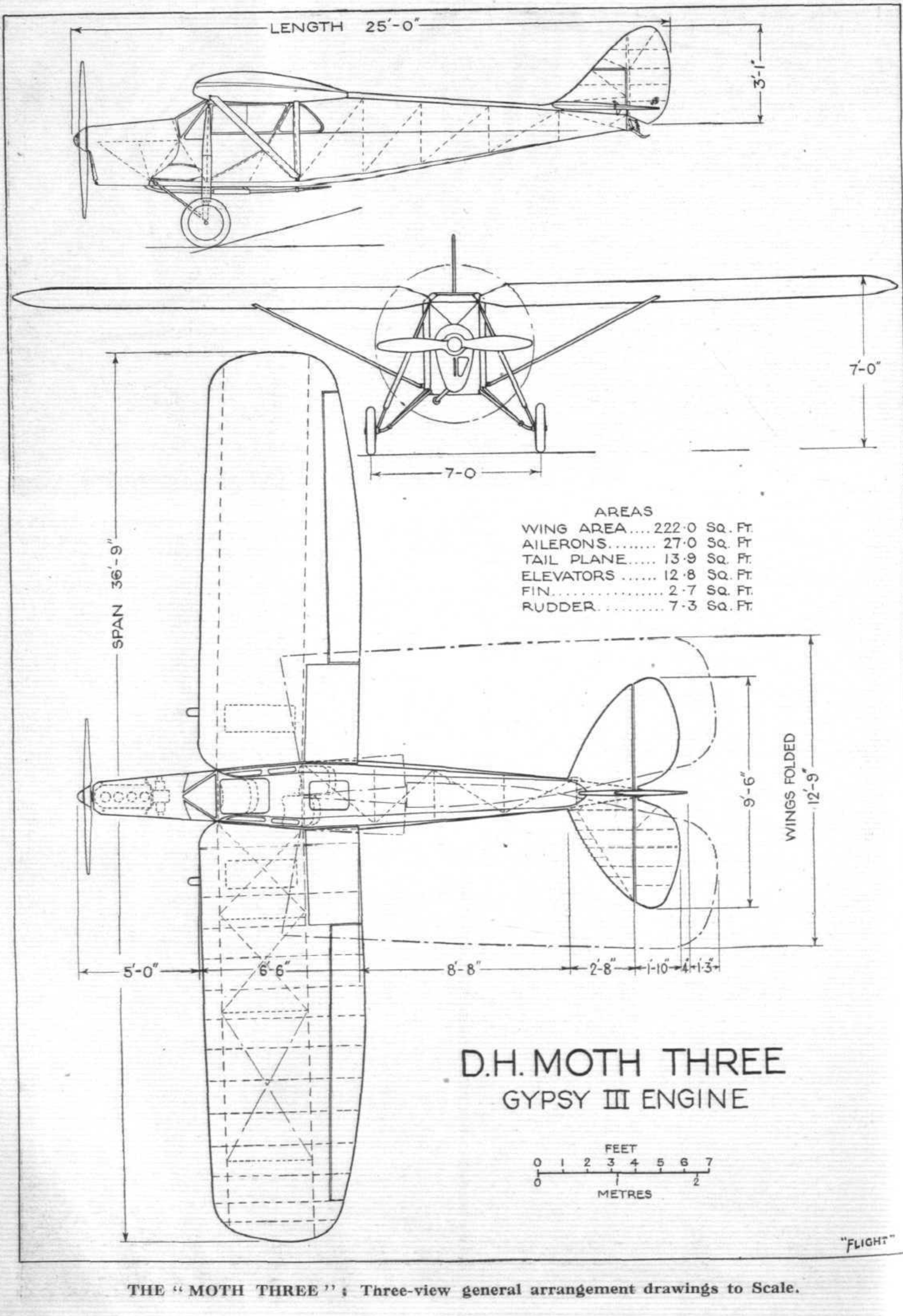
The monoplane wing is, as already mentioned, mainly of wood construction. The two main spars have top and bottom flanges of spruce and walls of three-ply. The leading edge is covered with plywood up to the rear edges of the front spar, the resulting D-section wooden "tube" being very strong in torsion.

Internal drag bracing is in three bays, of which the inner two are braced by duplicate cables and the outer by piano wire. In the bay at the root of the wing the drag bracing is dropped towards the bottom of the wing section so as to accommodate the petrol tanks, which are carried in the wing. The drag bracing struts are round-section steel tubes, and those in way of lift-strut attachments are in duplicate, the two forming a vee with its single point on the rear spar. On the front spar one tube runs straight across, while the second slopes forward and downward to support at its forward end the lift-strut fitting. This, of course, in order to take care of the compressive load which arises from the fact that the rear lift struts are in the plane of the rear spars for folding purposes, while the forward lift struts slope back at a considerable angle from front spar to lower longeron, thereby producing a rearward component. The arrangement is illustrated by a sketch. The wing ribs are of spruce, and of normal construction. The ailerons, of large span and small chord, are hinged to false spars placed a short distance aft of the rear spar. They are provided with the usual De Havilland type of differential control.

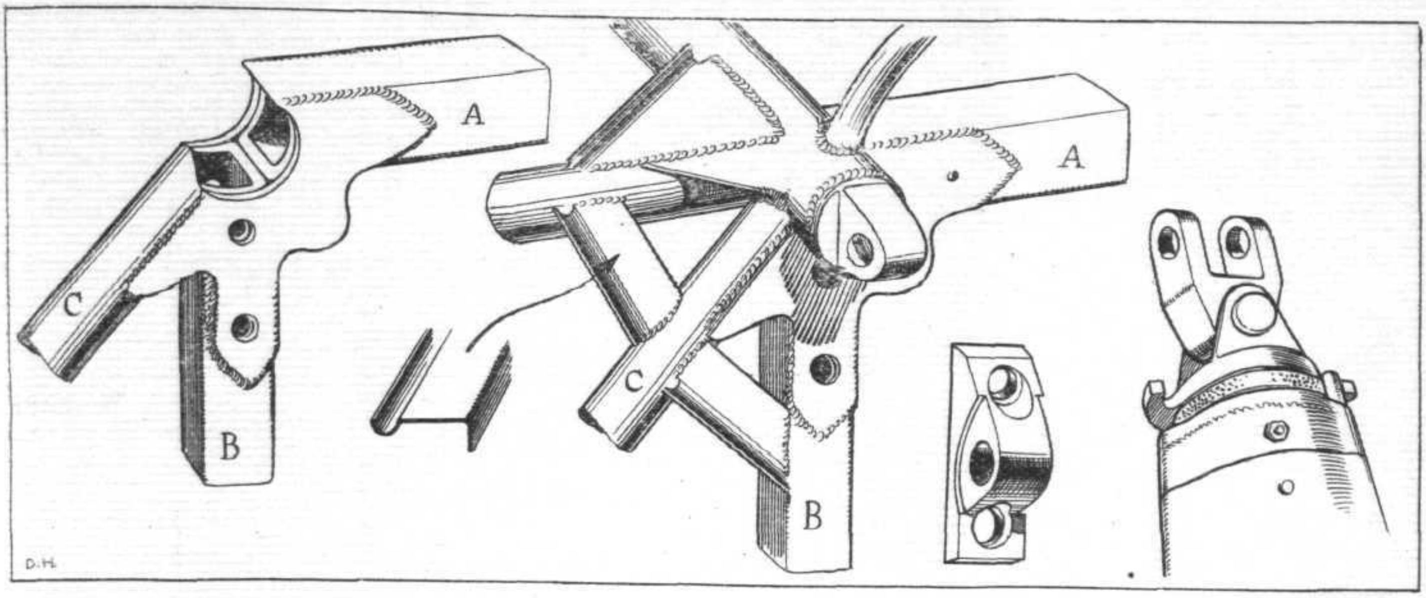
Streamline steel struts forming a vee brace the wings to the lower longerons. A light jury strut is carried on each side, and when the wings are folded this jury strut supports the forward corner of the inner end of the wing, the petrol tanks being carried inside the wing near this point.

A "split" type of undercarriage is fitted to the "Moth Three," consisting on each side of a telescopic member running to the top longeron, a bent axle to the lower longeron, and a radius rod to the forward bottom corner, near the engine mounting. Rubber blocks of streamline shape provide the shock-absorption, and the telescopic legs are further made to act as air brakes by being swivel-mounted at their ends in such a manner that they can be turned through an angle of 90°. Operation of the air brakes is by short cranks connected to a lever by the side of the pilot's seat.

THE "MOTH THREE": Three-quarter rear view. (FLIGHT *Photo.*)



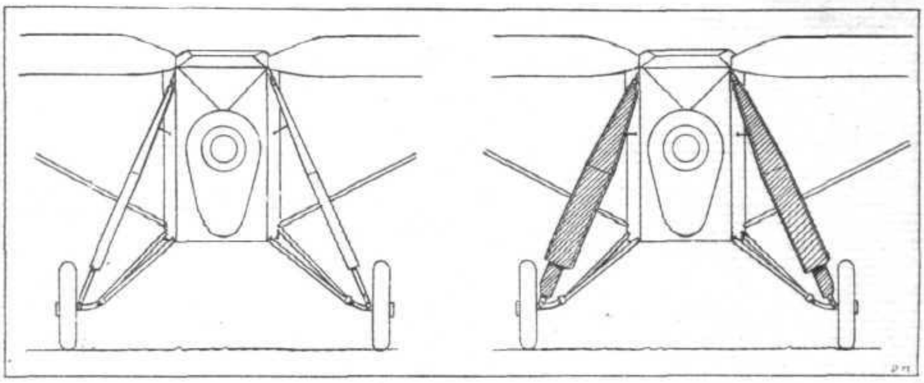
THE "MOTH THREE": Three-view general arrangement drawings to Scale.



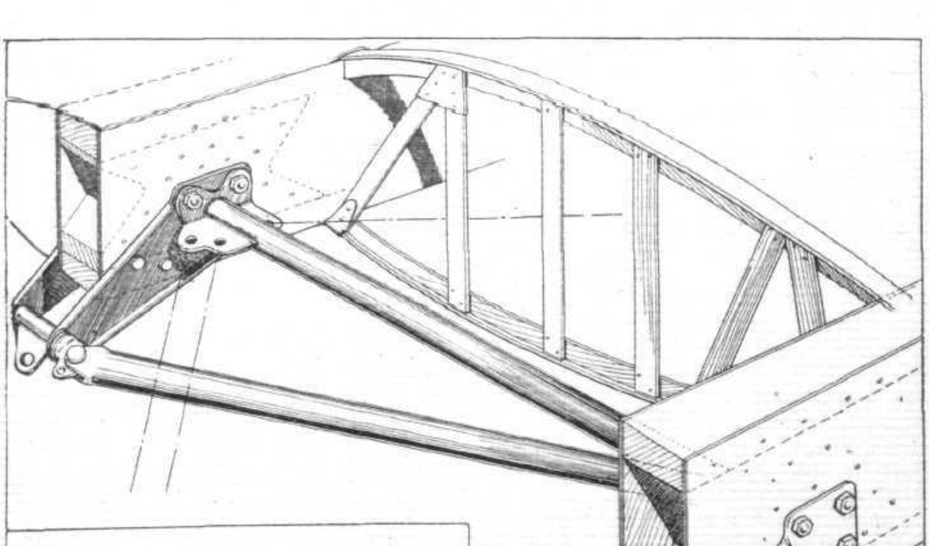
SOME "MOTH THREE" DETAILS: In the centre, the joint at the port front spar attachment, and on the left the joint dissected to show the construction. On the right the top end of the compression strut of the undercarriage, showing the swivel joint and stop for the strut when rotated to act as an air brake. (FLIGHT *Sketches*.)

The tail skid is sprung by a coil spring, and is steerably mounted to facilitate taxying on the ground. The rudder operates the tail skid *via* a peg in the bottom of the rudder and a fork on the tail-skid spindle. The object of the fork is to permit the rudder a certain amount of movement before the tail skid comes into operation. In this manner shocks transmitted to the rudder by the tail skid are reduced. On the lower end of the tail-skid spindle is a crank the two arms of which provide stops for the skid and limit its angular movement. Rubber pads are carried on the ends of the crank arms to avoid transmitting hard knocks to the sternpost of the fuselage. The whole tail-skid arrangement is well illustrated by one of our sketches.

One of the most interesting features of the "Moth Three" is the power plant installation, which consists of a "Gipsy III" inverted engine. This engine is practically identical with the "Gipsy II," except for certain modifications necessitated by the inversion. Owing to the fact that the cylinders are below the crankcase, the forward view from the cabin is remarkable, and is, in fact, very nearly as good as the view one used to obtain from the nacelle of our old "pushers." The four feet which connect the crankcase to the engine bearers rest in trunnions on the latter, and rubber pads are interposed between the feet and the trunnions in order to reduce the amount of vibration transmitted to the aircraft structure. A fireproof bulkhead separates the engine from the cabin. The engine is almost entirely cowled-in by a five-piece cowl, the parts of which are held on by long "skewers." At the back there is a slight gap between the side cowls and the side of the fuselage, so as to provide an escape for the air which enters through a small opening in the forward end of the cowling. Partly let into the port side of the fuselage covering, just aft of the fireproof bulkhead, is an oil tank which also serves as a cooler, this being made



Diagrammatic representation of the working of air brakes on the "Moth Three."

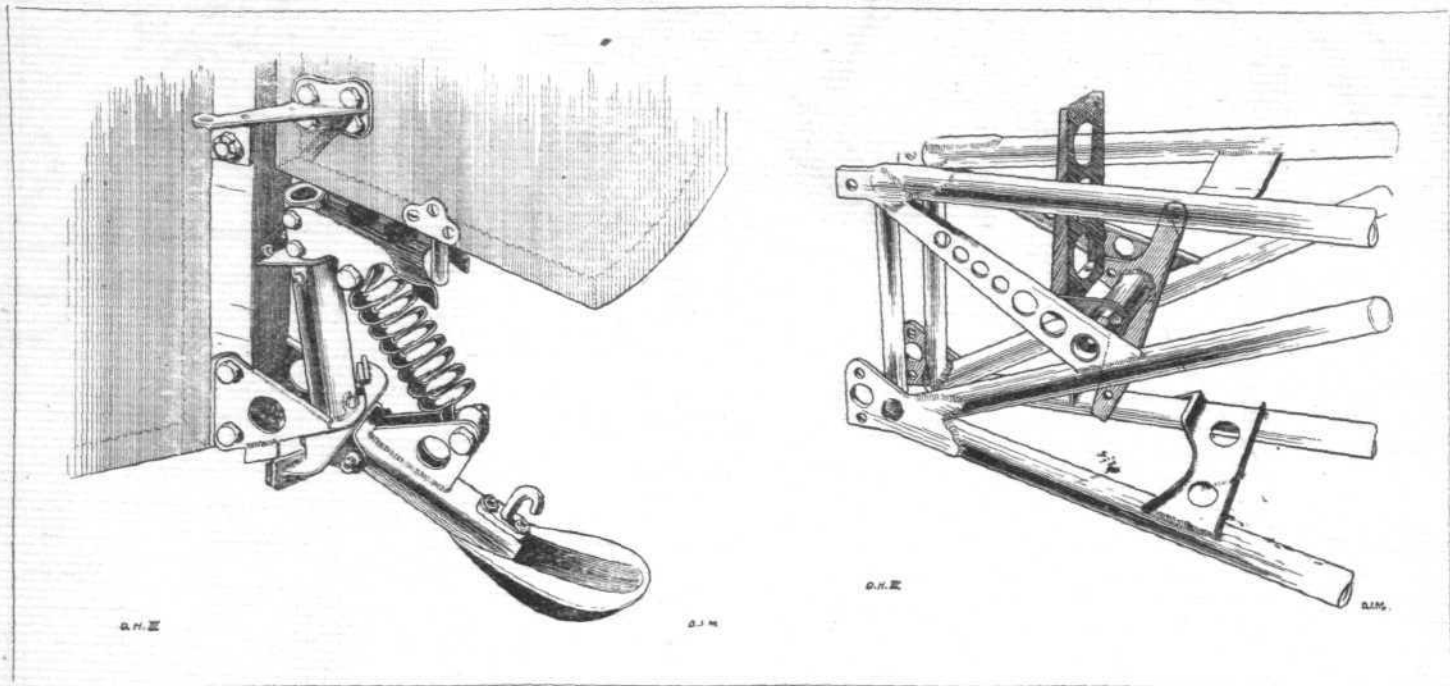


The internal drag struts of the "Moth Three" in way of lift strut attachments form a vee. Inset: Mounting and gauge of a petrol tank. (FLIGHT *Sketches*.)

necessary because the "Gipsy III" engine is of the dry sump type.

Mention has already been made of the fact that the petrol tanks are mounted in the wing, one on each side. The tanks are slung on steel straps fastened to light brackets on the main spars, and the removal of a tank is a simple matter. Each tank is provided at its lowest point with a combined

The pilot's controls are the usual, but are very neatly arranged so as to give the impression of the driver's seat of a car rather than the cockpit of an aeroplane. On the port side is the tail trimming gear, and on the starboard the lever which operates the air brakes. In front of the pilot is a very neatly arranged dash with instruments (Smith's), and below that a map table, running right across



THE MOTH "THREE": On the left a sketch of the steerable tail skid, and on the right details of tail trimming gear. (Flight *Sketches.*)

petrol gauge and sump, in the form of a plunger working in a tube, the glass of which projects below the wing covering. Thus not only can the pilot see at a glance how much petrol is left in the tanks, but any impurities, etc., drain into the sump and glass, where they are at once seen and can easily be removed. Three sizes of tanks have been standardised, giving ranges of 440 miles, 570 miles, and 700 miles, respectively, the useful load being, of course, correspondingly decreased.

The Cabin

The "Moth Three" will be marketed as an occasional three-seater. That is to say, the cabin lay-out is such that, normally, the machine will be equipped with two seats, arranged in tandem, with ample leg and elbow room. The seats, upholstery, interior decorations will be very attractive, and from personal experience it can be said that the machine is one of the most delightful to fly in that we have tried. Owing to the enclosed cabin, the inverted engine, and the enclosure of the valve rockers, etc., in steel casings, the noise which reaches the occupants is reduced to a point where it is not in the least objectionable. The profusion of windows, skylight, and windscreen admit plenty of light, so that, although the cabin is not large in actual dimensions, one has not that sense of being "cooped up," which is apt to spoil for some the enjoyment of flying in a small cabin machine.

The rear seat is arranged to slide along grooves running diagonally across the cabin floor. When the machine is to be used as a three-seater, the rear seat can be slid forward and across the cabin towards the starboard side, and the third seat added behind it, but on the port side. Leg room for the two passengers is then just a little bit cramped, but not seriously so.

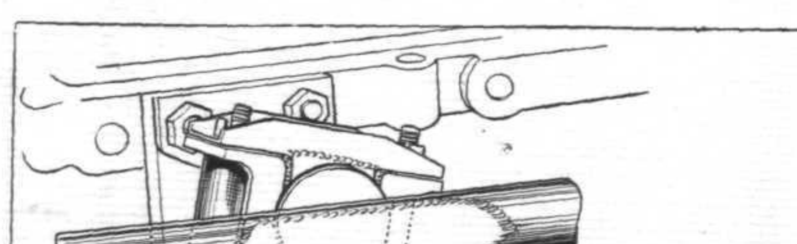
The pilot's seat is the forward one, and the view from it is remarkable. Not only does the inverted engine arrangement make an almost incredible difference to the view, but the windows in front and in the sides, as well as the large skylight, in conjunction with the tapering down of the wing spars towards the roots, afford views in nearly all directions above and below the wing.

the width of the cabin, and with wire spring clips for holding maps, etc., down on the map board. The instrument board is pivoted so as to facilitate access to the back of the various instruments.

Dual controls are provided, so that, if desired, the machine can be used for instructional work. When not in use, the rear control stick is unshipped and placed in clips on the side.

The "Moth Three" cannot fail to appeal strongly to private owners of aircraft. The price (£1,000) is somewhat high, but not unduly so, in view of the fact that the machine can be used occasionally as a three-seater, and that it has a high performance, coupled with excellent fuel economy at a cruising speed of more than 100 m.p.h.

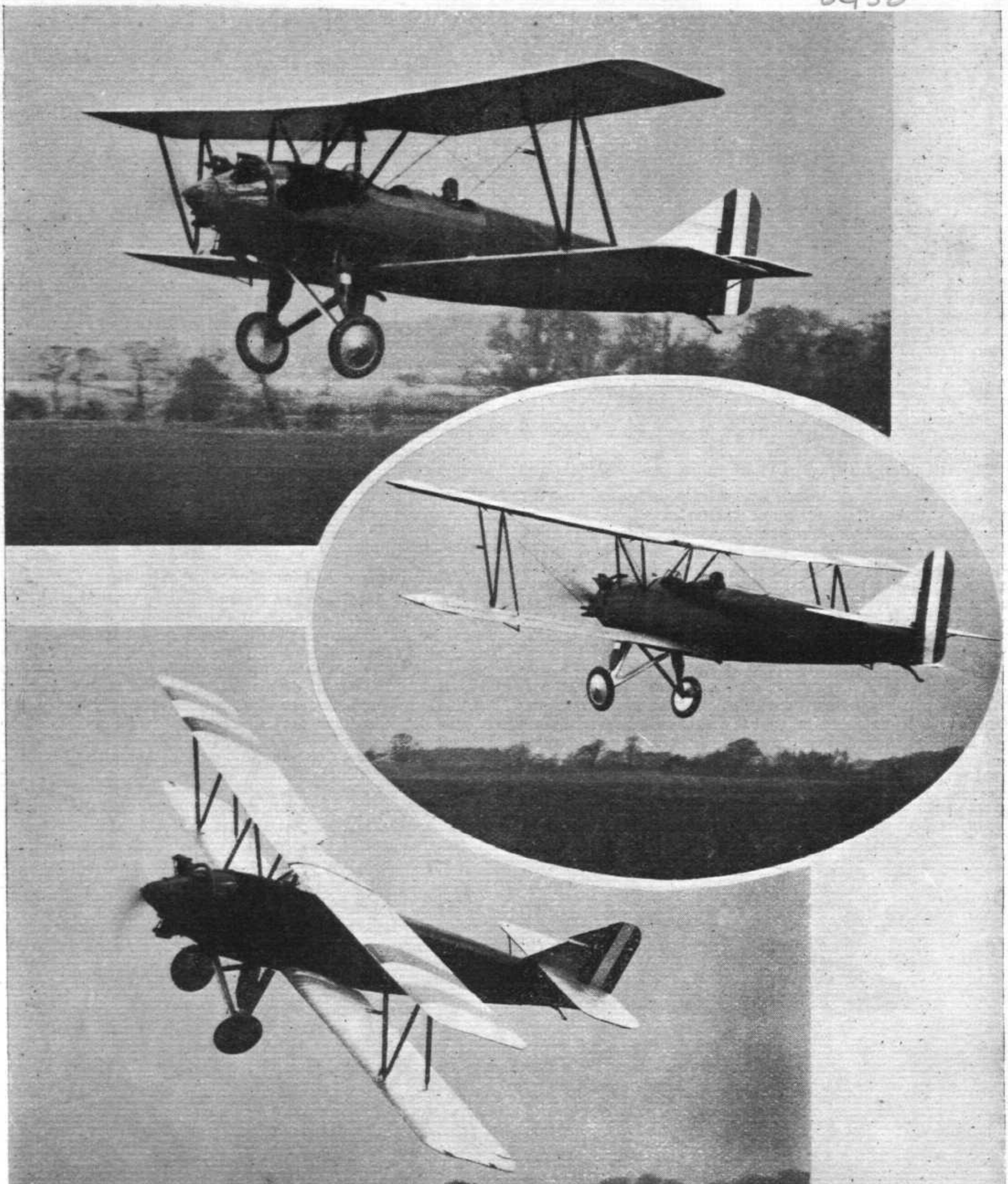
The machine is also supplied as a twin-float seaplane. The price is then £1,250.



The Mounting of the "Gipsy III" Engine in the "Moth Three" makes use of rubber pads in trunnion supports to damp vibration. (Flight *Sketches.*)

THE AVRO "TRAINER"

8438



844

843

A NEW ALL-METAL TRAINING MACHINE: After undergoing tests at Martlesham, the new Avro "Trainer" has now gone into production, and a batch of machines is being built. Several have also been ordered for use in the Dominions and abroad, some for air survey work. The machine can be fitted with the Armstrong-Siddeley "Mongoose" engine (standard) or with the "Lynx" for special purposes, such as operating from aerodromes situated at a considerable altitude. A detailed description will be published next week. (FLIGHT *Photos.*)

AIR TRANSPORT

FOUR YEARS' AIR TRANSPORT IN U.S.A.

According to figures issued by the United States Assistant Secretary of Commerce for Aeronautics there has been a marked increase in scheduled air transport activities during the past four years.

In the four-year period from 1926 to 1929, inclusive, the most interesting feature is the increase in number of passengers carried. In 1926 there were 5,782 persons carried on the scheduled routes then operating, while in 1929, the estimated number was 150,000, or an increase of 2,492 per cent. Air mail poundage during the period increased from 810,855 lb. in 1926 to 7,700,000 lb. in 1929, while mileage flown by mail 'planes increased from 4,240,407 miles in 1926 to 16,000,000 miles in 1929.

While the number of United States air transport operators increased from 18 in 1926 to 35 in 1929, or 94 per cent., the number of routes operated by these companies was developed from 18 to 97 or by 439 per cent.

On December 31, 1926, there were 8,404 miles of airways operated by the air transport companies, of which 8,039 were for air mail. On December 31, 1929, there were 36,000 miles of airways in operation, of which 26,597 miles were used by the air mail. The mileage actually flown by the operators increased 409 per cent., or from 4,318,087 in 1926, with a daily average of 11,830 miles, to 22,000,000 miles in 1929 or 60,273 miles average daily. At the present time the daily scheduled mileage is 90,000.

'Planes and personnel engaged in the operation of scheduled air transport activities increased from 128 'planes, 127 pilots and 355 other personnel in 1927, to 525 'planes, 500 pilots and 1,500 personnel in 1929.

Of the 36,000 miles of airways operated during 1929, 11,456 miles were to Canada, Central and South America, and the West Indies. Over these 11,456 miles of international air ways, six United States air transport companies maintained 14 routes, carried 670,000 lb. of mail, and flew 2,000,000 miles during 1929.

Development of these inter-American services has been satisfactory when compared with the 185 miles of airways operated from the United States during 1926, over which 55,839 lb. of mail were carried and 34,266 miles were flown by two operators.

It is pointed out that scheduled air transportation constitutes only 15 per cent. of all civil and commercial flying activities in the United States. Figures covering the remaining 85 per cent.—miscellaneous operations, which include student instruction, air taxi operations, aerial photography, crop dusting, experimental flying and private flying—are not yet available.

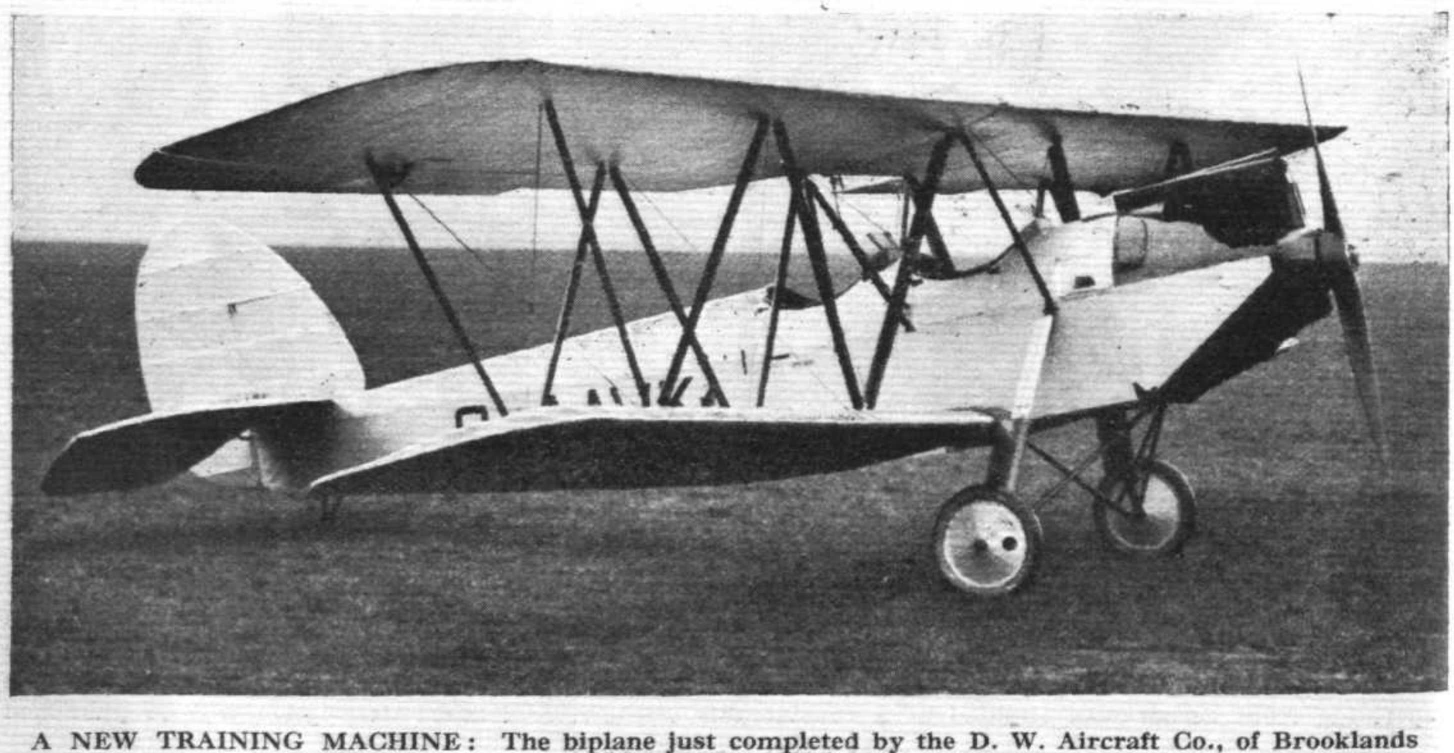
Western Australian Airways Statistics

Airways Bulletin gives the following statistics regarding Western Australian Airways services up to March 3, 1930: Passengers carried: (Perth-Derby), 7,155; (Perth-Adelaide), 2,528; Taxi and Joy-ride, 13,490. Machine flights: 10,040. Miles flown: 1,443,507. Letters carried: (Perth-Derby), to December, 1929, 1,667,169; (Perth-Adelaide), 73,611 lb. Freight carried: (Perth-Derby), 292,128 lb.; (Perth-Adelaide), 12,946 lb.

The *Bulletin* adds that towards the end of February, heavy rains which commenced on the north-west coast of the State, travelled across the Continent, and so heavy were the falls on the Nullabor Plain, that it was soon in a state of flood—6 in. being recorded in the space of six days. The trans-Australian railway line became inundated, and trains were held up, and as a result threw increased traffic on the aerial service. Except for a couple of days when the service was delayed by reason of the flooded aerodrome at Forrest, the air service maintained its regular schedule—which was not very easy to do, and pilots and mechanics were called upon to work long hours.

U.S. Government Aid for Merchant Airships

Senator MacNary, of Oregon, has sponsored a Bill in the U.S. Senate to encourage the construction in the United States by American capital of American airships capable of engaging in foreign trade. Direct subsidies will not be given, but airships will be awarded mail contracts if capable of carrying 10,000 lb. of mail and a suitable commercial load. Three projects depend on this legislation, namely, the Pacific Zeppelin Transport Company, to run a service to Hawaii and the Philippines; the Orient International Zeppelin Transport Company, in co-operation with Germany, to establish a Transatlantic service; and, thirdly, the Aircraft Development Corporation, to link the islands of the Caribbean.



A NEW TRAINING MACHINE: The biplane just completed by the D. W. Aircraft Co., of Brooklands Aerodrome, has very light wing loading and consequently a low landing speed. Note the Warren girder wing bracing. The engine is a "Cirrus." (Flight *Photo.*)

The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

Edited by C. M. POULSEN

April 25, 1930

CONTENTS

METAL CONSTRUCTION DEVELOPMENT

By H. J. Pollard, Wh.Ex., A.F.R.Ae.S.

(*continued from p.* 92)

We are very glad to welcome back to our columns this month, Mr. Pollard, who has been absent (as a contributor) since our December 27, 1929, *issue, owing to illness. Mr. Pollard has undergone an operation, and is now, we are pleased to learn, feeling quite fit again. In the present issue he returns to the subject of wing structure weights, using for the purpose of his investigation a machine of the semi-cantilever type, in which the wing area is kept constant, but the aspect ratio is raised until the aeroplane weight is equal to the weight of the pure cantilever machine. In other words, the machine in which the weight saved by bracing with external struts the spars one-third of their length out from the root is utilised in increasing the span and thus reducing the span loading and reducing the induced drag.*

In the first part of this article (December, 1929), we examined the comparative weights of the wing structures of semi-cantilever and pure-cantilever monoplanes of a particular size, the machines being identical in all respects except for the anchorage of the supporting surfaces; we will now extend the investigation to a third machine of the semi-cantilever type, in which the wing area is kept constant, but the aspect ratio is raised until the total aeroplane weight is equal to that of the pure cantilever type.

Most readers realise that a general and logical attack on the problem of optimum design is an impossibility, but to make this clear let us consider such an expression as

$$f(x, y, a_1, a_2, a_3 \cdots) = 0 \quad \dots\dots\dots\dots\dots\dots \quad (1)$$

in which the quantities $a_1, a_2 \cdots$, which are called variable parameters, are each settled by a different feature in the construction of the aeroplane. Obviously, if we gradually vary any of the parameters, the curve will gradually alter in shape, position, or both. The unknown dependent variables x and y may represent, say, speed and ceiling, and there is a combination of values a_1, a_2, etc., which gives optimum values to x and y. Now when it is realised that a few of these parameters in aeroplane design are surface loading, horse-power loading, aspect ratio, wing section, propellers and supercharging, the laboriousness and probable futility of attempting to build up and use equations, such as (1) with the idea of obtaining the envelope of the whole family of curves, and from this to obtain the optima for the dependent variables, is at once obvious. Let us then be content with obtaining approximate solutions to small parts of the general problem.

Proceeding with the case of our third machine, in which the wing span is increased and the chord diminished until the total machine weight is raised from 16,300 lb. to 17,000 lb., the external tie being still attached at point k, Fig. 3 (*see* Aircraft Engineer, page 90, December, 1929).

In the absence of an initial complete set of weights of the components of the finished wing, an accurate deduction of the weights of the components of a new wing of the same form is not possible, but it may be useful to indicate how such a computation can be made.

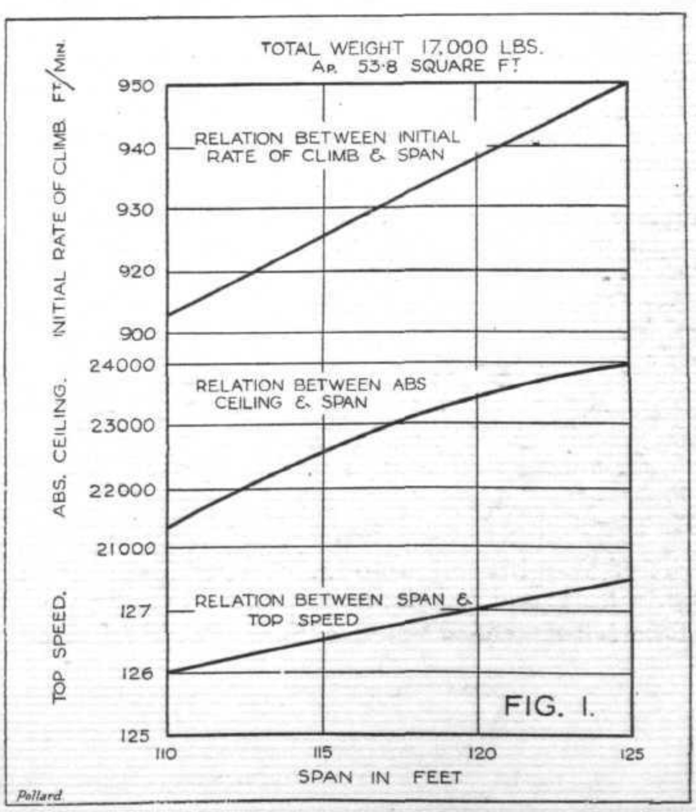


FIG. 1.

No change is made in the basic aerofoil section. If L represents a typical span dimension, then the depth of the spar varies as $L^{-1}\left(\frac{1}{L}\right)$, and the end loads in the booms vary as L^2. Assuming the buckling loads of all the struts to vary as L^2, then the compression boom weight varies as L^4 and the tension boom weight varies as L^3.

The variation of diagonal tie weight with L is involved, but over the range we are considering it is sufficiently accurate to assume that the weight varies as $L^{1\cdot5}$, while the weight of the vertical struts varies as L^{-2}.

Further complication is introduced by reason of the fact that the fuselage depth remains constant, while the span is increased. In an actual computation, however, one would take the weight of the bottom boom from the point k to the root varying as L^4, while considered as a tie the external member weight varies approximately as L^2.

The weight of the plan view members joining the two plane frames composing the whole spar can be considered constant ; so also with the weight of the gusset plates.

As to the ribs, we may assume that the ratio of rib spacing to chord is constant, in which case the number of ribs varies as L^2, and consequently the load per rib varies as L^{-2}. If the ribs are geometrically similar, the length of component members varies as L^{-1}, and if the strength of these members varies as L^2 the section area varies as L^{-2}, and consequently the total rib weight varies as L^{-1}.

Similar arguments may be advanced for the weight of the leading and trailing edges, while the weight of the covering is constant. In a similar way the variation of the weight of the internal drag bracing can be derived.

As previously stated, if we had a complete set of weights for the components of a wing of the type, it would be possible to estimate accurately the new weight for a variation in L, providing it were possible to keep the stresses constant in similar members of the two structures. We have also seen that, in the case of these laminated spars at any rate, a new weight estimate could be made with fair precision, but in other parts, such as ribs and edges, it would be practically impossible to vary the sectional area of the members according to the above relationship. This is simply due to the difficulty of providing the minimum area of metal necessary for the attainment of uniformly high stresses in places where the applied loads are relatively small.

The best that can be done at the moment then is to take what appears to be a reasonable length for the new span, and this we will fix at 120 ft., an increase of 25 ft. It remains then to estimate the partial performance of the machines (the top speed near the ground, rate of climb and absolute ceiling only being considered). For this purpose we will make use of the method given in the article by Mr. Ivan H. Driggs which appeared in the August, September and October (1927) issues of this Supplement, entitled "A Simple Theoretical Method of Analysing and Predicting Airplane Performance," and for the benefit of readers who do not possess these copies we will quote the necessary formulæ :—

$$\frac{F_p}{F_r} e_{max.} K_p V_{max.} - \frac{F_i}{F_r} = 0\cdot00000872\, V^4_{max.} \quad \text{......... (1)}$$

$$K_p = \left(\frac{V_{des.}}{V_{max.}}\right)^{\frac{1}{3}} = 1$$

$$p_r^{\frac{3}{4}} = \frac{0\cdot095\, F_i^{\frac{3}{4}} F_r^{\frac{1}{4}}}{F_p\, e_{max.}\, {}_1K_p} \quad \text{.................................... (2)}$$

$${}_1K_p = \left(\frac{V_{M.P.}}{V_{des.}}\right)^{\frac{1}{3}} \text{ and } V_{M.P.} = 14\left(\frac{F_i}{F_r}\right)^{\frac{1}{4}}$$

$$\text{Rate of climb} = 33{,}000\, F_p\, e_{max.}\, {}_2K_p - 3588\, F_i^{\frac{3}{4}} F_r^{\frac{1}{4}} \quad \text{... (3)}$$

$${}_2K_p = \left(\frac{V_{M.P.}}{V_{des.}}\right)^{\frac{1}{2}} \text{ and } V_{M.P.} = 18\cdot4\left(\frac{F_i}{F_r}\right)^{\frac{1}{4}}$$

$$e_{max.} = 1 - \frac{0\cdot425\, P_m^{\frac{1}{4}} N^{\frac{1}{2}}}{(V_{des.})^{\frac{3}{4}}} = \text{max. prop. efficiency.}$$

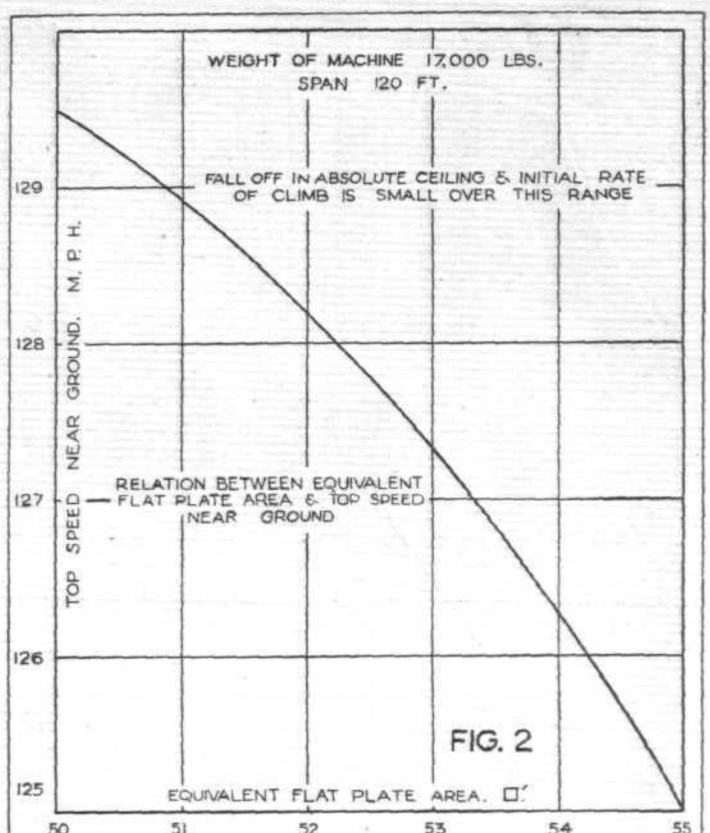


FIG. 2

In the above

P_m = Engine B.H.P.

N = Revs. of prop. r.p.m. at designed speed (V des.). in m.p.h.

$$F_p = \frac{\text{Total b.h.p.}}{\text{Aeroplane weight (W lb.).}}$$

$$F_r = \frac{A_p}{W} = \frac{\text{Parasitic resistance as equivalent flat-plate area sq. ft.}}{W}$$

Parasitic resistance includes body and wing profile drag *i.e.*, total resistance less induced drag.

$$F_i = \frac{W}{3\,(\text{span})^2} \text{ for a monoplane.}$$

$V_{M.P.}$ = Velocity of minimum power in m.p.h.

$V_{cl.}$ = Velocity of climb in m.p.h.

pr = is the relative power of the motor at altitude.

Driggs gives an alternative formula for $pr^{\frac{3}{4}}$, which should be used for calculating the ceiling in cases such as the ones we are considering, but since we are not concerned with the accurate determination of the absolute ceiling but only with the comparative values, there is no need to use or quote the alternative formula.

Each engine develops 445 h.p. at 1,700 r.p.m., giving 1,335 h.p. for three engines. Wing area 1,400 sq. ft. in each case.

	Case 1. Pure Canti-lever.	Case 2. Semi-Canti-lever.	Case 3. Semi-Cantilever. (High Aspect Ratio.)
Span (feet) ...	95	95	120
A_p sq. ft. ...	48	53	53·8
Weight (lb.) ...	17,000	16,300	17,000
Maximum speed (m.p.h.) ...	131	125·5	127·0
Absolute ceiling	19,100	19,200	23,400
Rate of climb (ft./min.) ...	867	907	937
Vel. minimum power ...	54·2	51·7	47

No comment is necessary on the values of Ap (the equivalent flat plate area) selected, except that an increase of 5 sq. ft. for the external struts appears to be a very liberal allowance. Both this and the weight difference may be regarded as extreme values. For the benefit of readers who have other views on what they consider appropriate values of the span for Case 3 and the flat-plate equivalent, we have plotted values of V max. ceiling and rate of climb for various spans ; similarly these performance characteristics are estimated for the same case, using a varying Ap.

This comparison shows that the introduction of struts leaves the performance of the machine unaltered on the whole. The main consideration in the case of the pure cantilever machine is the rigidity of the wings in torsion, and such evidence as exists points to this as a problem of grave difficulty for spans such as we have considered.

Apart from structural questions, it is very doubtful whether the slight gain in top speed is compensated for by the loss of the other characteristics tabulated. The power expended in propelling the external struts through the air is of some 6 or 7 per cent. of the total, an obviously important matter when considering the suitability of either structure for long-distance work, for in this case the saving in structure weight could easily be exceeded by the extra fuel requirements of the braced monoplane.

Although no binding conclusions are here drawn, it is the writer's belief that the best arrangement of large monoplane wings at the present stage of development lies in having external struts attached at a point about one-third of the spar length from the root, thus relieving the heaviest stresses, at the same time giving only moderate interference.

This applies to cases of pure bending only, and in cases where the structure is torsionally stiff. This stiffness is obtained in any of the following three ways :—(*a*) "rigid" covering, metal or 3-ply, (*b*) one, two, or more spars used in conjunction with pyramidal bracing, or other internal anti-torsion devices, (*c*) a multi-spar arrangement ; this latter may be metal covered or fabric covered. In the latter case the plan view spar-interconnecting bracing needs to be specially stiff. In the case of wings tapering in plan and front view and by giving aero-dynamic twist to the wings and also by reducing lateral control to an absolute minimum, really large pure cantilever structures can be used. For example, in the Junkers G.38, where the total span is nearly 150 ft., with a pure cantilever structure of approximately 70 span. But where two spars are used, as in an ordinary biplane wing, and no special device is used to resist torsion, then long external members are indispensable. One cannot generalise on the probable best position for these members. The relation of spar depth at the root to span, the design of rib and the method of securing the ribs to the spars, likewise the form of the drag bracing, are important matters bearing on the stiffness of the structure. A matter, however, of even greater importance is the torsion induced by the use of ailerons. While wings having small movement of centre of pressure assist in reducing torsion, this is of small account compared with the twisting moment arising from aileron movement. Attempts have been made at obtaining lateral control by means other than with ailerons, but there is no immediate likelihood of this method of control being abandoned. If it *could* be abandoned, the design of large monoplanes would be much simplified.

Although the question of torsional stiffness is nearly as important as that of direct strength, yet this consideration should not prevent a theoretical solution of the problem of the use or disuse of external members in monoplanes, and their best position when used. This matter is capable of logical treatment in special cases, provided reasonably accurate formulæ can be derived giving variation in wing weights with variation in wing form.

For certain types of multi-spar monoplane wings, where a uniform stress can be closely attained, such formulæ can be obtained without serious difficulty.

STRENGTH AND STIFFNESS.

By "RUNE"

IN the lecture on "Certificates of Airworthiness" which he delivered before the Royal Aeronautical Society on January 23, Mr. Howard pointed out that it is highly probable that our "normal" category aircraft, designed in accordance with the current Air Ministry strength requirements, are stronger than they need be. He said that "there seems, therefore, some reason to hope that strength factors might be reduced in the air-liner class without any practical reduction in their safety."

Should the reduction in strength factors suggested actually come to pass, it may well be that designers will find themselves unable to effect the saving in weight which the strength reduction would appear to indicate. This is because reduction in strength is generally associated with reduction in stiffness, and an apparently safe reduction in strength may produce an unsafe reduction in stiffness.

There are at least two ways in which reduction of wing stiffness, for instance, may affect the safety of an aeroplane : it may cause diminution or even complete loss of lateral control, and it may reduce the critical flutter speed of the aircraft. The former effect depends, of course, mainly on torsional stiffness, as a wing tends to twist and thereby change its incidence, under aileron loads. The other effect is associated, in addition, with the flexural stiffness of the wing and with the stiffness moment about the aileron hinge due to the elasticities in the control system ; if these stiffnesses are all multiplied by a given factor, the critical flutter speed is multiplied by the square root of that factor.*

The spars are, of course, the most important factors affecting wing stiffness, and, to a first approximation, in the conventional type of wing, the flexural stiffness of the wing depends on their flexural stiffnesses, and the torsional stiffness of the wing on their flexural stiffnesses and on the distance between them. The effect of reduction of spar flexural strength on spar flexural stiffness is therefore a matter of primary importance, and one, it is thought, that would repay further investigation on the part of designers now that a reduction in strength factors for a certain class of aircraft is, to go no further than Mr. Howard, something to hope for.

A thorough discussion of the question would necessarily introduce considerations of the type generically and conveniently called "practical." As has been suggested, it is a designer's problem, and, moreover, it cannot be dissociated from experimental research. It is possible, however, with the help of one or two assumptions, to give some indication on very simple lines of the kinds of relationships that can exist between flexural stiffness and flexural strength.

The stiffnesses of uniform beams of the same length, similarly supported and loaded, are proportional, if shear deflections are neglected, to the appropriate moments of inertia of their cross-sections. Their strengths are proportional to the corresponding moduli of cross-section.

Suppose, now, that the strength of a beam is reduced by multiplying all the dimensions of its cross-section normal to the plane of bending by k, all lengths and thicknesses parallel to the plane of bending remaining the same. Then the flexural strength, flexural stiffness, and weight of the beam are all multiplied by k. Moreover, if both spars of a wing are dealt with in this way, the torsional stiffness is also multiplied by k.

Reduction of strength and stiffness without reduction of what may conveniently be termed "vertical" dimensions, however, may not be acceptable from a practical point of view. A more compact procedure would be the overall reduction of the section by multiplying *every* dimension by k. Then flexural stiffness is multiplied by k^4, flexural strength by k^3, and area of cross-section by k^2. As k decreases, clearly stiffness decreases more rapidly than strength, and strength more rapidly than the weight of the beam. These variations are shown graphically in Fig. 1, wherein corresponding values lie on the same vertical line. The reduction

* Cf. Fraser and Duncan. R. & M. 1155, p. 45.

No change is made in the basic aerofoil section. If L represents a typical span dimension, then the depth of the spar varies as $L^{-1}\left(\frac{I}{L}\right)$, and the end loads in the booms vary as L^2. Assuming the buckling loads of all the struts to vary as L^2, then the compression boom weight varies as L^4 and the tension boom weight varies as L^3.

The variation of diagonal tie weight with L is involved, but over the range we are considering it is sufficiently accurate to assume that the weight varies as $L^{1 \cdot 5}$, while the weight of the vertical struts varies as L^{-2}.

Further complication is introduced by reason of the fact that the fuselage depth remains constant, while the span is increased. In an actual computation, however, one would take the weight of the bottom boom from the point k to the root varying as L^4, while considered as a tie the external member weight varies approximately as L^2.

The weight of the plan view members joining the two plane frames composing the whole spar can be considered constant ; so also with the weight of the gusset plates.

As to the ribs, we may assume that the ratio of rib spacing to chord is constant, in which case the number of ribs varies as L^2, and consequently the load per rib varies as L^{-2}. If the ribs are geometrically similar, the length of component members varies as L^{-1}, and if the strength of these members varies as L^2 the section area varies as L^{-2}, and consequently the total rib weight varies as L^{-1}.

Similar arguments may be advanced for the weight of the leading and trailing edges, while the weight of the covering is constant. In a similar way the variation of the weight of the internal drag bracing can be derived.

As previously stated, if we had a complete set of weights for the components of a wing of the type, it would be possible to estimate accurately the new weight for a variation in L, providing it were possible to keep the stresses constant in similar members of the two structures. We have also seen that, in the case of these laminated spars at any rate, a new weight estimate could be made with fair precision, but in other parts, such as ribs and edges, it would be practically impossible to vary the sectional area of the members according to the above relationship. This is simply due to the difficulty of providing the minimum area of metal necessary for the attainment of uniformly high stresses in places where the applied loads are relatively small.

The best that can be done at the moment then is to take what appears to be a reasonable length for the new span, and this we will fix at 120 ft., an increase of 25 ft. It remains then to estimate the partial performance of the machines (the top speed near the ground, rate of climb and absolute ceiling only being considered). For this purpose we will make use of the method given in the article by Mr. Ivan H. Driggs which appeared in the August, September and October (1927) issues of this Supplement, entitled "A Simple Theoretical Method of Analysing and Predicting Airplane Performance," and for the benefit of readers who do not possess these copies we will quote the necessary formulæ :—

$$\frac{F_p}{F_r} e_{max.} K_p V_{max.} - \frac{F_i}{F_r} = 0 \cdot 00000872 \, V^4_{max.} \quad \text{......... (1)}$$

$$K_p = \left(\frac{V_{des.}}{V_{max.}}\right)^{\frac{1}{2}} = 1$$

$$p_r^{\frac{2}{3}} = \frac{0 \cdot 095 \, F_i^{\frac{1}{4}} \, F_r^{\frac{3}{4}}}{F_p \, e_{max.} \, {}_1K_p} \quad \text{.. (2)}$$

$${}_1K_p = \left(\frac{V_{M.P.}}{V_{des.}}\right)^{\frac{1}{4}} \text{ and } V_{M.P.} = 14 \left(\frac{F_i}{F_r}\right)^{\frac{1}{4}}$$

$$\text{Rate of climb} = 33{,}000 \, F_p \, e_{max.} \, {}_2K_p - 3588 \, F_i^{\frac{3}{4}} F_r^{\frac{1}{4}} \quad \text{... (3)}$$

$${}_2K_p = \left(\frac{V_{M.P.}}{V_{des.}}\right)^{\frac{1}{2}} \text{ and } V_{M.P.} = 18 \cdot 4 \left(\frac{F_i}{F_r}\right)^{\frac{1}{4}}$$

$$e_{max.} = 1 - \frac{0 \cdot 425 \, P_m^{\frac{1}{3}} N^{\frac{1}{3}}}{(V_{des.})^{\frac{2}{3}}} = \text{max. prop. efficiency.}$$

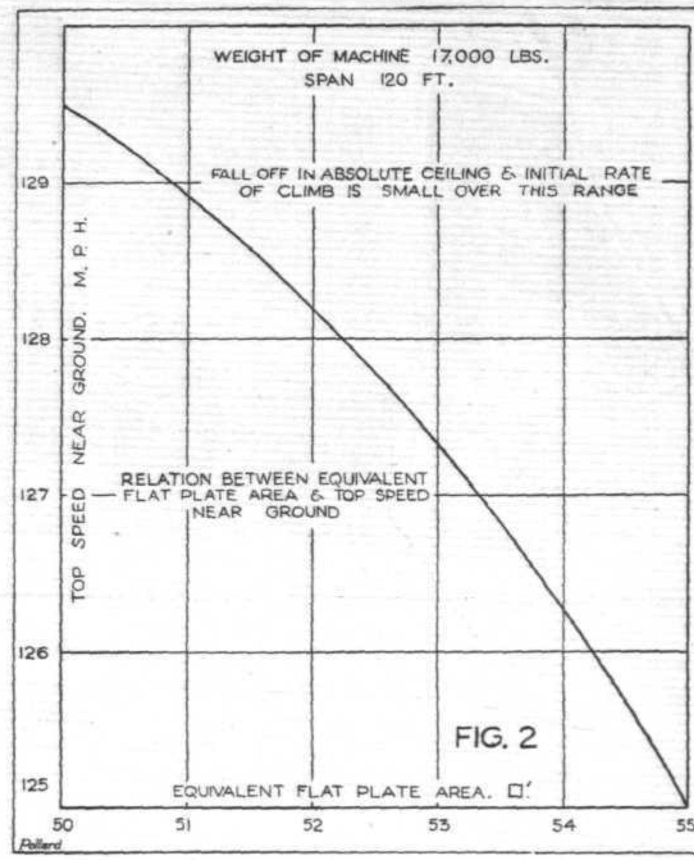


FIG. 2

In the above

P_m = Engine B.H.P.

N = Revs. of prop. r.p.m. at designed speed (V des.). in m.p.h.

$$F_p = \frac{\text{Total b.h.p.}}{\text{Aeroplane weight (W lb.).}}$$

$$F_r = \frac{A_p}{W} = \frac{\text{Parasitic resistance as equivalent flat-plate area sq. ft.}}{W}$$

Parasitic resistance includes body and wing profile drag *i.e.*, total resistance less induced drag.

$$F_i = \frac{W}{3 \, (\text{span})^2} \text{ for a monoplane.}$$

$V_{M.P.}$ = Velocity of minimum power in m.p.h.

$V_{cl.}$ = Velocity of climb in m.p.h.

pr = is the relative power of the motor at altitude.

Driggs gives an alternative formula for $pr^{\frac{2}{3}}$, which should be used for calculating the ceiling in cases such as the ones we are considering, but since we are not concerned with the accurate determination of the absolute ceiling but only with the comparative values, there is no need to use or quote the alternative formula.

Each engine develops 445 h.p. at 1,700 r.p.m., giving 1,335 h.p. for three engines. Wing area 1,400 sq. ft. in each case.

	Case 1. Pure Canti-lever.	Case 2. Semi-Canti-lever.	Case 3. Semi-Cantilever. (High Aspect Ratio.)
Span (feet) ...	95	95	120
A_p sq. ft. ...	48	53	53·8
Weight (lb.) ...	17,000	16,300	17,000
Maximum speed (m.p.h.) ...	131	125·5	127·0
Absolute ceiling	19,100	19,200	23,400
Rate of climb (ft./min.) ...	867	907	937
Vel. minimum power ...	54·2	51·7	47

No comment is necessary on the values of *Ap* (the equivalent flat plate area) selected, except that an increase of 5 sq. ft. for the external struts appears to be a very liberal allowance. Both this and the weight difference may be regarded as extreme values. For the benefit of readers who have other views on what they consider appropriate values of the span for Case 3 and the flat-plate equivalent, we have plotted values of V max. ceiling and rate of climb for various spans ; similarly these performance characteristics are estimated for the same case, using a varying *Ap*.

This comparison shows that the introduction of struts leaves the performance of the machine unaltered on the whole. The main consideration in the case of the pure cantilever machine is the rigidity of the wings in torsion, and such evidence as exists points to this as a problem of grave difficulty for spans such as we have considered.

Apart from structural questions, it is very doubtful whether the slight gain in top speed is compensated for by the loss of the other characteristics tabulated. The power expended in propelling the external struts through the air is of some 6 or 7 per cent. of the total, an obviously important matter when considering the suitability of either structure for long-distance work, for in this case the saving in structure weight could easily be exceeded by the extra fuel requirements of the braced monoplane.

Although no binding conclusions are here drawn, it is the writer's belief that the best arrangement of large monoplane wings at the present stage of development lies in having external struts attached at a point about one-third of the spar length from the root, thus relieving the heaviest stresses, at the same time giving only moderate interference.

This applies to cases of pure bending only, and in cases where the structure is torsionally stiff. This stiffness is obtained in any of the following three ways :—(*a*) "rigid" covering, metal or 3-ply, (*b*) one, two, or more spars used in conjunction with pyramidal bracing, or other internal anti-torsion devices, (*c*) a multi-spar arrangement ; this latter may be metal covered or fabric covered. In the latter case the plan view spar-interconnecting bracing needs to be specially stiff. In the case of wings tapering in plan and front view and by giving aero-dynamic twist to the wings and also by reducing lateral control to an absolute minimum, really large pure cantilever structures can be used. For example, in the Junkers G.38, where the total span is nearly 150 ft., with a pure cantilever structure of approximately 70 span. But where two spars are used, as in an ordinary biplane wing, and no special device is used to resist torsion, then long external members are indispensable. One cannot generalise on the probable best position for these members. The relation of spar depth at the root to span, the design of rib and the method of securing the ribs to the spars, likewise the form of the drag bracing, are important matters bearing on the stiffness of the structure. A matter, however, of even greater importance is the torsion induced by the use of ailerons. While wings having small movement of centre of pressure assist in reducing torsion, this is of small account compared with the twisting moment arising from aileron movement. Attempts have been made at obtaining lateral control by means other than with ailerons, but there is no immediate likelihood of this method of control being abandoned. If it *could* be abandoned, the design of large monoplanes would be much simplified.

Although the question of torsional stiffness is nearly as important as that of direct strength, yet this consideration should not prevent a theoretical solution of the problem of the use or disuse of external members in monoplanes, and their best position when used. This matter is capable of logical treatment in special cases, provided reasonably accurate formulæ can be derived giving variation in wing weights with variation in wing form.

For certain types of multi-spar monoplane wings, where a uniform stress can be closely attained, such formulæ can be obtained without serious difficulty.

STRENGTH AND STIFFNESS.

By "Rune"

In the lecture on "Certificates of Airworthiness" which he delivered before the Royal Aeronautical Society on January 23, Mr. Howard pointed out that it is highly probable that our "normal" category aircraft, designed in accordance with the current Air Ministry strength requirements, are stronger than they need be. He said that "there seems, therefore, some reason to hope that strength factors might be reduced in the air-liner class without any practical reduction in their safety."

Should the reduction in strength factors suggested actually come to pass, it may well be that designers will find themselves unable to effect the saving in weight which the strength reduction would appear to indicate. This is because reduction in strength is generally associated with reduction in stiffness, and an apparently safe reduction in strength may produce an unsafe reduction in stiffness.

There are at least two ways in which reduction of wing stiffness, for instance, may affect the safety of an aeroplane : it may cause diminution or even complete loss of lateral control, and it may reduce the critical flutter speed of the aircraft. The former effect depends, of course, mainly on torsional stiffness, as a wing tends to twist and thereby change its incidence, under aileron loads. The other effect is associated, in addition, with the flexural stiffness of the wing and with the stiffness moment about the aileron hinge due to the elasticities in the control system ; if these stiffnesses are all multiplied by a given factor, the critical flutter speed is multiplied by the square root of that factor.*

The spars are, of course, the most important factors affecting wing stiffness, and, to a first approximation, in the conventional type of wing, the flexural stiffness of the wing depends on their flexural stiffnesses, and the torsional stiffness of the wing on their flexural stiffnesses and on the distance between them. The effect of reduction of spar flexural strength on spar flexural stiffness is therefore a matter of primary importance, and one, it is thought, that would repay further investigation on the part of designers now that a reduction in strength factors for a certain class of aircraft is, to go no further than Mr. Howard, something to hope for.

A thorough discussion of the question would necessarily introduce considerations of the type generically and conveniently called "practical." As has been suggested, it is a designer's problem, and, moreover, it cannot be dissociated from experimental research. It is possible, however, with the help of one or two assumptions, to give some indication on very simple lines of the kinds of relationships that can exist between flexural stiffness and flexural strength.

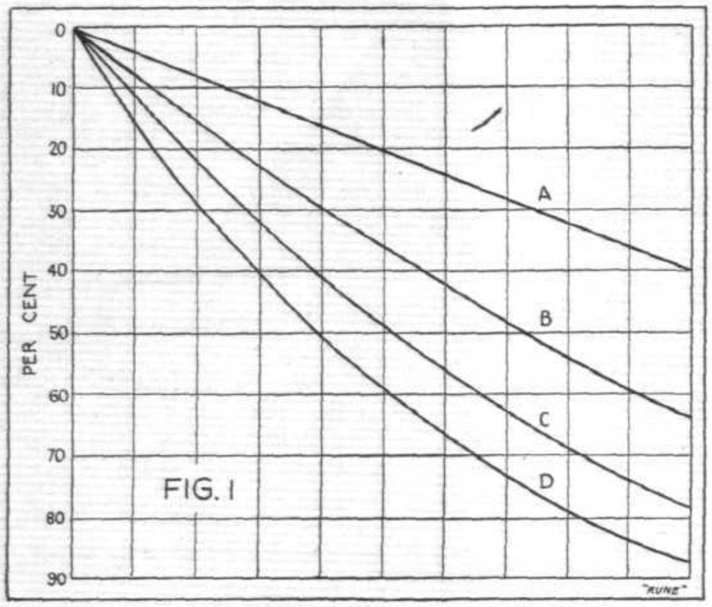
The stiffnesses of uniform beams of the same length, similarly supported and loaded, are proportional, if shear deflections are neglected, to the appropriate moments of inertia of their cross-sections. Their strengths are proportional to the corresponding moduli of cross-section.

Suppose, now, that the strength of a beam is reduced by multiplying all the dimensions of its cross-section normal to the plane of bending by k, all lengths and thicknesses parallel to the plane of bending remaining the same. Then the flexural strength, flexural stiffness, and weight of the beam are all multiplied by k. Moreover, if both spars of a wing are dealt with in this way, the torsional stiffness is also multiplied by k.

Reduction of strength and stiffness without reduction of what may conveniently be termed "vertical" dimensions, however, may not be acceptable from a practical point of view. A more compact procedure would be the overall reduction of the section by multiplying *every* dimension by k. Then flexural stiffness is multiplied by k^4, flexural strength by k^3, and area of cross-section by k^2. As k decreases, clearly stiffness decreases more rapidly than strength, and strength more rapidly than the weight of the beam. These variations are shown graphically in Fig. 1, wherein corresponding values lie on the same vertical line. The reduction

* Cf. Fraser and Duncan. R. & M. 1155, p. 45.

of all dimensions simultaneously appears to be an uneconomical procedure, but it must be borne in mind that, in a given wing section, it might, by permitting a greater distance between spars, produce a considerably less rapid rate of decrease for torsional stiffness than that for flexural stiffness.



Curve A : Reduction in Linear Dimensions of Cross-section. Curve B: Reduction in Cross-sectional Area. Curve C: Reduction in Strength. Curve D: Reduction in Stiffness.

It can easily be seen that reduction by multiplication of vertical dimensions only is a still more uneconomical procedure from the point of view of flexural stiffness, though it might possibly be in some cases advantageous if torsional stiffness of the wing is the primary consideration.

It is conceivable that a particular spar section may be of the minimum allowable stiffness for a given aircraft but still too strong. It might then be advisable to modify it so that both strength and stiffness had the minimum allowable values. If the original and final moments of inertia of the section are I and I′, and the original and final depths of section are d and d', and if the strength is finally to be n times the original strength, the conditions are

$$\mathrm{I}' = \mathrm{I}$$

$$\frac{\mathrm{I}'}{d'} = \frac{n\mathrm{I}}{d}$$

and therefore $$d' = \frac{d}{n}$$

It is, that is to say, necessary to increase the depth of the spar. It may be instructive to see what kind of law of variation for the dimensions this requires in the case of a simple box section such as is shown in Fig. 2. The dimensions of the original section are given in the figure, and in the following the dashed letters refer to the modified section.

$$\mathrm{I}' = \frac{b' \cdot t'_{\mathrm{F}}{}^3}{6} + \frac{b' \cdot t'_{\mathrm{F}} \cdot d'^2}{2} + \frac{t'_{\mathrm{W}}\, d'^3}{6} = \mathrm{I} = \frac{b \cdot t_{\mathrm{F}}{}^3}{6} + \frac{b \cdot t_{\mathrm{F}} \cdot d^2}{2} + \frac{t_{\mathrm{W}} \cdot d^3}{6}$$

Putting $d' = \dfrac{d}{n}$

$$\frac{b' \cdot t'_{\mathrm{F}}{}^3}{6} + \frac{b' \cdot t'_{\mathrm{F}} d^2}{2n^2} + \frac{t'_{\mathrm{W}} d^3}{6n^3} = \frac{b t_{\mathrm{F}}{}^3}{6} + \frac{b \cdot t_{\mathrm{F}} \cdot d^2}{2} + \frac{t_{\mathrm{W}} \cdot d^3}{6}$$

A possible solution is therefore

$$b' = n^3 b$$

$$t'_{\mathrm{F}} = \frac{t_{\mathrm{F}}}{n}$$

$$t'_{\mathrm{W}} = n^3 t_{\mathrm{W}}$$

$$d' = \frac{d}{n}$$

which is to say that vertical dimensions are multiplied by $\frac{1}{n}$, horizontal dimensions by n^3. The original area A was $2bt_{\mathrm{F}} + 2d \cdot t_{\mathrm{W}}$. The modified area A′ is $2 \cdot b't'_{\mathrm{F}} + 2d't_{\mathrm{W}}' = n^2\mathrm{A}$. The procedure appears to be economical from the point of view of weight saving, though this effect might be negatived if the increased depth necessitated another and deeper wing section.

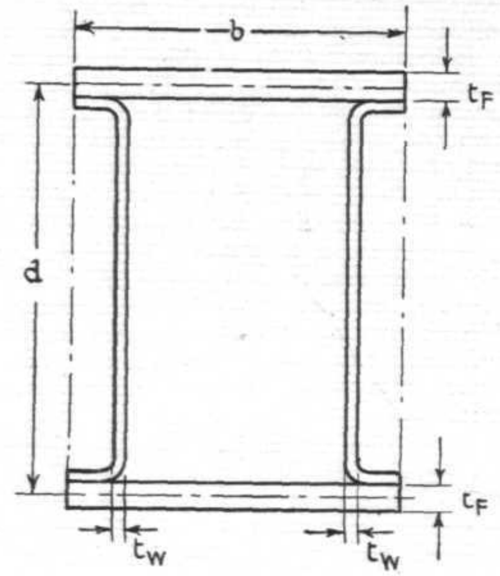


FIG. 2.

It may be objected that this, that, and the other have been neglected in the foregoing paragraphs: they have. It is thought, however, that there is more than sufficient truth to indicate the need for some careful investigations into the relations between strength and stiffness of aircraft structures, even were the probability of factor reduction mentioned above quite negligible.

WHEELS AND TYRES.

Mechanical and Aerodynamic Properties.

By GEORGE H. DOWTY, A.F.R.Ae.S., M.I.Ae.Eng.

The synthetic moulding trade is a comparatively new industry, but is growing very rapidly. Its work embraces such products as those marketed under the proprietary name of "Bakelite," "Micarta," etc., and there are already many aircraft components fabricated in this material, such as airscrews, tail wheels, control wheels, fairleads, electrical equipment, dashboards, rudder bar mountings, etc. In America, rubber is being used in the manufacture of sheet-metal pressings, the cost of production being reduced because of the fact that no matched dies are required. There are some very promising developments taking place in these industries, which should be of great interest to aircraft engineers, and we are very glad to have, from Mr. Dowty, of the technical staff of the Gloster Aircraft Co., Ltd., an article dealing with recent wheel and tyre tests.

During the past year a number of reports have been published, in the technical press of the Rubber and Synthetic Moulding Industries, dealing with aircraft products supplied by these trades.

In view of the interest and value of this information the writer has endeavoured to classify this work and present it under a few major groupings, making due reference, wherever possible, to the source from which the material has been obtained.

In this article it is proposed to deal with those components manufactured by the rubber industry, commencing with tyres and wheels.

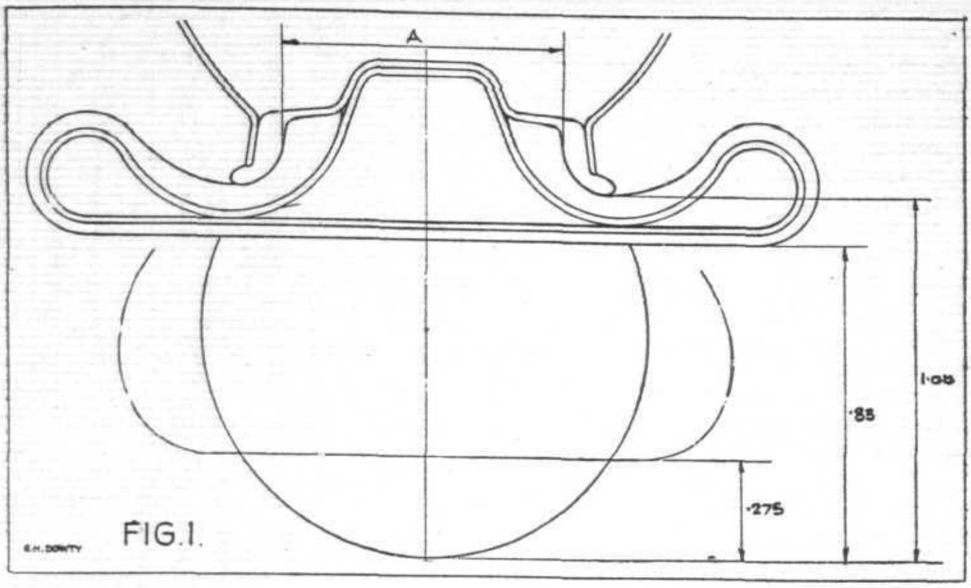


FIG. 1.

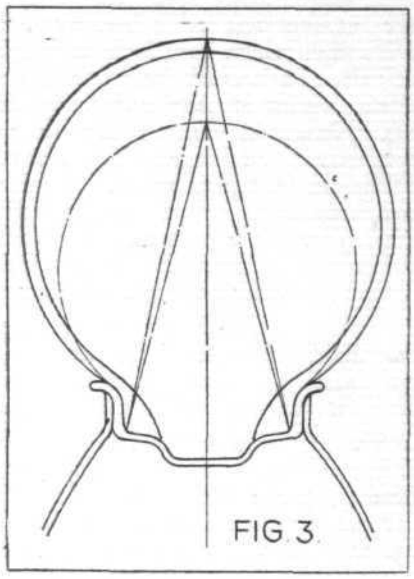


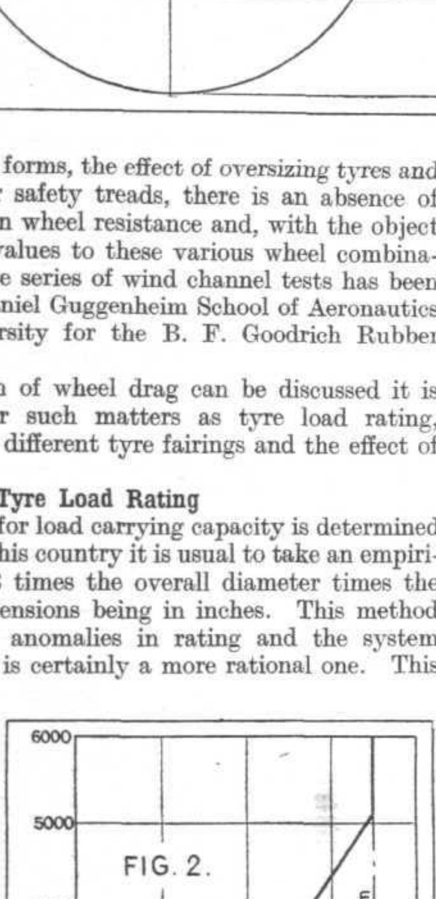
FIG. 3.

With various wheel forms, the effect of oversizing tyres and the use of smooth or safety treads, there is an absence of reliable information on wheel resistance and, with the object of assigning definite values to these various wheel combinations, a comprehensive series of wind channel tests has been carried out by the Daniel Guggenheim School of Aeronautics of New York University for the B. F. Goodrich Rubber Corporation.

Before the question of wheel drag can be discussed it is necessary to consider such matters as tyre load rating, contours provided by different tyre fairings and the effect of oversizing.

Tyre Load Rating

The rating of tyres for load carrying capacity is determined in several ways. In this country it is usual to take an empirical value of 12 or 13 times the overall diameter times the tyre width, both dimensions being in inches. This method gives rise to certain anomalies in rating and the system employed in America is certainly a more rational one. This method rates tyres according to a definite radial deflection taken as a percentage of the cross-sectional height of the tyre measured from the point of extreme overall diameter to the top of the rim flange. Tyres are rated for static load on the basis of a radial deflection equal to 27½ per cent. of this distance. On this basis the tyre cannot deflect 100 per cent. because twice the thickness of the tyre and tube intervenes between the rim flange and the ground at complete collapse of the tyre.



Load v. Deflection Chart of 30 × 5 Aircraft Tyre on 30 × 5 Rim. Inflation Pressure, 50 lb. per sq. in.

This condition is shown on Fig. 1. In the case of 30 × 5 tyre equipment the maximum possible deflection is about 83 per cent. Fig. 2 shows a loading diagram for a 30 × 5 tyre, loaded to its maximum deflection. On a load rating basis of 12 Dd this size of tyre is given a static load capacity of 1,800 lbs., but it will be noted that at a load of 5,100 lbs. the tyre is completely flattened against the rim. The ratio between static load and the load corresponding to complete flattening of the tyre is 1,800 : 5,100 or 1 : 2·83. The maximum designed load which the tyre must carry is approximately 1,800 × 4 or 7,200 lbs. It is obvious that under conditions of maximum allowed impact the tyre is completely flattened and severely pinched between the rim and ground. This condition is undesirable and, it is presumed, tolerated only because the tyre has the ability to withstand this punishment.

The ideal condition for the tyre would be to have its collapsing load equal to the static load multiplied by the load factor, but this would reduce tyre rating to 1,270 lbs., or 0·7 of its present rating.

Before leaving the question of tyre rating, reference must be made to one further method in which the load carrying capacity is fixed by the area of contact.

For all practical purposes it can be considered that the area of contact is the same for equal tyre deflections, regardless of inflation pressure, and the load supported by the tyre is equal to the product of the area of contact multiplied by the inflation pressure.

The flattening of the tread, due to deflection of the tyre, bears a simple mathematical relation to the area of contact.* The area of contact is an ellipse equal to :—

$$\frac{\pi A B}{4}$$

where A and B are the major and minor axes of the ellipse.

The length of these axes can be approximated closely from the formula for the chord subtended by the arc of the segment of a circle.

Where :—

R = radius of wheel (with tyre). in.
r = radius of tyre section. in.
x = radial deflection. in.

Then the length of the axes, in inches, can be written as follows :—

$$A = 2\sqrt{R^2 - (R - x)^2}$$
$$B = 2\sqrt{r^2 - (r - x)^2}$$

Tyre Oversizing

It is often found desirable to fit a larger section tyre to a given wheel and the possibility of doing so is largely a question of tyre stability. This factor is intimately connected with rim design and wheel diameter.

The angle of stability for a tyre section is shown in Fig. 3, and is the angle formed by a line drawn from the heel of each bead to the centre line of the tyre tread. This angle on automobile tyres is usually limited to a maximum of 28 degrees, as any lesser angle would give an unstable combination, tending to roll the tyre off the rim. Automobile practice was followed for several years until impact loads of landing caused bending of the rim flanges. To overcome these difficulties oversizing was carried out and, in some instances, the stability

angle was reduced to as little as 20 degrees. No difficulties were encountered and it has been proved that the conditions of stability which hold for automobile tyres do not apply to aircraft. In this connection it can be stated that as a principle of rim design for aircraft wheels, the rim width "A," see Fig. 1, should be from 0·5 to 0·6 the tyre section rather than 0·7, which is a common dimension in automobile practice.

The standard 19 or 20-in. rim allows fitting of oversize tyres as follows :—

30 × 5 tyre on 28 × 4 wheel.
32 × 6 tyre on 28 × 4 wheel.
32 × 6 tyre on 30 × 5 wheel.
36 × 8 tyre on 32 × 6 wheel.

The chief disadvantage against the use of oversized tyres is the greater tyre width in relation to width of rim and the large cavity formed between the tyre wall and wheel sides. Unless this is covered by a satisfactory fairing the increase in wheel drag will be very appreciable.

Wheel Fairings.

In the case of wire-spoke wheels it has been usual to fit flexible shields, generally fabricated in linen or rubberised fabric. The most efficient form of fairing is one which extends from the tyre wall at its point of maximum width and runs to the wheel hub. The Palmer and Dunlop systems are well known, the former employs metal loops embedded in the tyre wall and the fairings are provided with hooks to locate in the metal loops. The canvas fairings used on Dunlop wire wheels are secured by steel clips riveted to the underside of the rim, the fairings being provided with inextensible edges of steel wire. In both these systems the shield fairings are provided with holes to give access to the lubricator and inflation valve.

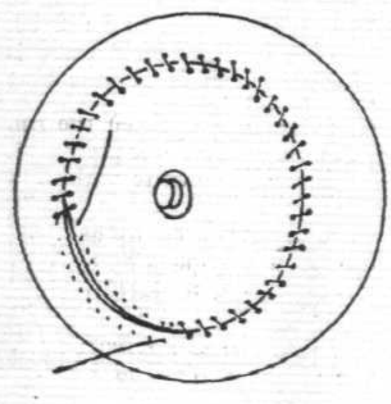


FIG. 4. G.N. DOWTY

It is well known that fairings which leave a gap between the tyre wall are inefficient and have the effect of considerably increasing the wheel drag. The actual values of these fairings will be considered later on.

Available data would indicate that it is equally important for metal disc wheels to be faired with close-fitting shields. The problem of designing a suitable fairing is difficult since the fairing must be flexible to permit tyre distortion and flattening, while it is essential that they must be quickly assembled and easily maintained.

The most efficient wheel fairing so far marketed is the Goodrich streamline shield. These fairings are made of rubberised stockinette, or plain fabric, and reinforced around the edges. The tyre is provided with skirts, vulcanised to the walls at the greatest cross sectional point, and the shields are laced to the skirt through grommets. An illustration of this system is shown in Fig. 4.

Wheel Drag.†

In the following discussion, dealing with the aerodynamic resistance of wheels, reference will be made to the three sections shown in Fig. 5. Fig. 5A shows a section through a standard 30 × 5 wheel with fairings from hub to rim and, in the test report which follows, the wheels in question were fitted with fairings fabricated in aluminium sheet. Fig. 5B shows the same wheel with fairings from tyre to hub, while Fig. 5C shows a standard metal disc wheel with no additional fairings. This latter type is similar in section to that shown in Fig. 5A, and it will be assumed that the air resistances of these sections are similar.

In some undercarriage forms the wheel mounting is such that "toe in" and "toe out" of the wheels take place, and these tests include drag values for wheels inclined to the direction of flight.

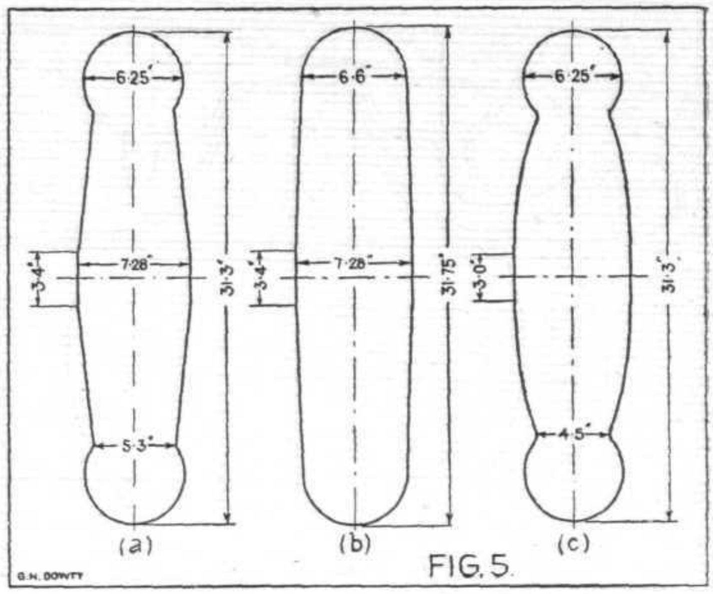


FIG. 5.

Twenty different tests are titled in Table I, and the drag values, for air speeds up to 90 m.p.h., are recorded on Figs. 6, 7 and 8.

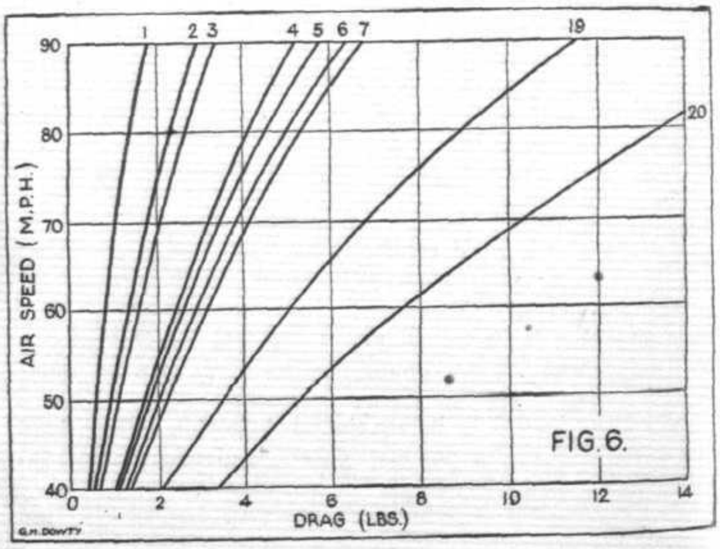
TABLE 1.—*Wheels and Tyres*

Test No.	Size. Tyre.	Wheel.	Tread.	Contour.	Toe in. Deg.	Ins.
1.	14 × 3	14 × 3	Smooth	—	—	—
2.	20 × 4	18 × 3	,,	—	—	—
3.	20 × 4	18 × 3	Safety	—	—	—
4.	30 × 5	28 × 4	Smooth	Stream-line	—	—
5.	30 × 5	28 × 4	,,	,,	2° 2′	0·35
6.	30 × 5	28 × 4	,,	,,	4° 4′	0·70
7.	30 × 5	28 × 4	,,	,,	6° 6′	1·05
8.	30 × 5	28 × 4	Smooth	—	—	—
9.	30 × 5	28 × 4	,,	—	2° 2′	0·35
10.	30 × 5	28 × 4	,,	—	4° 4′	0·70
11.	30 × 5	28 × 4	,,	—	6° 6′	1·05
12.	30 × 5	28 × 4	Safety	—	—	—
13.	32 × 6	28 × 4	,,	—	—	—
14.	32 × 6	36 × 6	Smooth	Stream-line	—	—
15.	32 × 6	32 × 6	,,	—	—	—
16.	32 × 6	32 × 6	Safety	—	—	—
17.	32 × 6	32 × 6	—	—	—	—
18.	32 × 6	32 × 6	Smooth	—	—	—
19.	36 × 8	36 × 8	,,	—	—	—
20.	40 × 10	36 × 8	Safety	—	—	—

Smooth and Non-Skid Treads.

Direct comparison can be made between tests 2 and 3; 15 and 16. In both cases it will be noticed that the increase in resistance, due to fitting non-skid tyres, is 0·4 lb. per wheel at 90 m.p.h.

In tests 2 and 3 the wheel frontal area was approximately 80 sq. in. and in tests 15 and 16 the frontal area was 192 sq. in., and although the increase in drag is shown to be similar



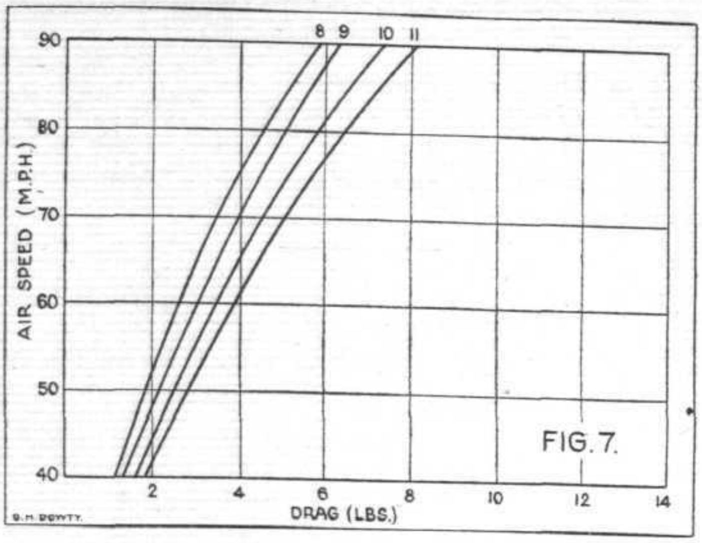


FIG. 7.

for these two types there can be little doubt that this value will increase with larger tyre sections.

Oversizing.

Increase in drag due to oversizing tyres can be seen by comparing tests 12 and 13. In this case a 30 × 5 tyre has been replaced by a 32 × 6, and the resistance has increased by 2·3 lb. at 90 m.p.h.

Tests 19 and 20 show the effect of replacing a 36 × 8 smooth tread by a 40 × 10 non-skid pattern. The increase recorded in this instance is 5·7 lb. at 90 m.p.h.

Fairings.

Tests 4 and 8 are directly comparable, the former representing a wheel similar to that shown on Fig. 5B, and the latter as shown on Fig. 5A. The difference in drag, in favour of the tyre-faired wheel is 0·6 lb. at 90 m.p.h. Comparing tests 14 and 15 we find that the difference in drag for tyre versus rim fairings on a 32 × 6 wheel is 0·4 lb. at 90 m.p.h., but referring to test 18 we see that a wire wheel, of similar size, with no fairings shows an increased resistance of 10·4 lb. at a similar air speed.

It follows that the most important drag reduction can be effected by providing satisfactory shields from hub to rim and that the hub-to-tyre fairing, although saving a certain amount of drag, is of secondary importance excepting when oversized tyres are employed.

Toe In.

The effect of toeing in is shown on tests 4, 5, 6 and 7 for wheels with tyre fairings, and on tests 8, 9, 10 and 11 for wheels with rim to hub fairings. In both series of tests 30 × 5 tyres were used mounted on 28 × 4 wheels.

When tyre fairings are employed the increased drag per wheel for 2, 4 and 6 degrees toe in is 0·6, 1·1 and 1·5 lb., respectively, at an air speed of 90 m.p.h.

For rim to hub fairings, the increase is 0·6, 1·6 and 2·3 lb. for similar angles of toe in and at the same air speed.

It will be noticed that tyre fairings show a smaller drag

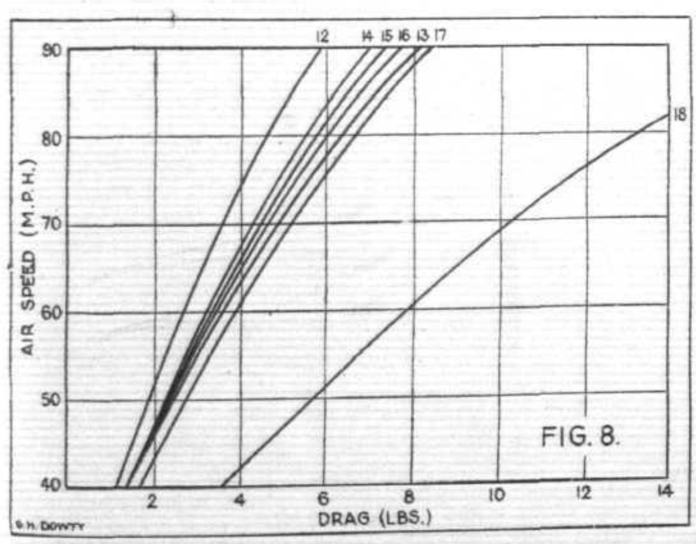


FIG. 8.

increase and are therefore of greater value on types of undercarriage in which the wheels toe in or out.

The design of undercarriages which necessitate wheels being angled to the direction of flight is not sound, since there is considerable waste of horse-power. If the design is such that the wheel is square when in flight then the wheels will be out of track during taxi-ing, and this will result in a scuffing action on the tyres, producing excessive wear. In addition, the wheels will give an increased ground drag, or braking action, which will increase the take off run.

General.

From the foregoing remarks it would appear that :—

(1) The use of non-skid, or safety pattern treads, will not seriously increase wheel resistance.

(2) Oversize tyres should only be employed in conjunction with tyre fairings.

(3) For standard wheels and tyres—squarely mounted—the provision of rim to hub fairings is quite efficient and little improvement can be gained by the use of tread fairings.

(4) Toe in or toe out of wheels should be carefully avoided.

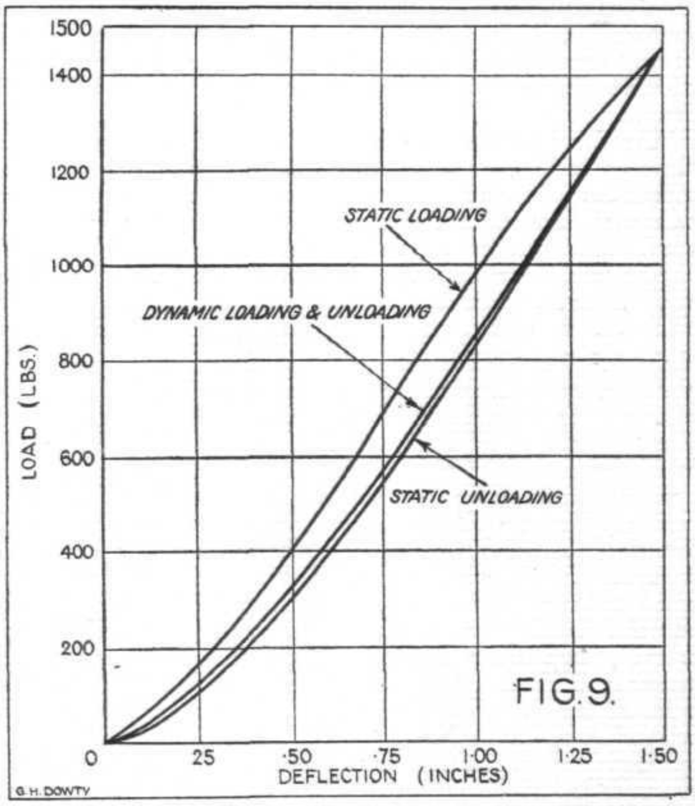


FIG. 9.

Load Deflection Graph of Stationary and Rolling Tests at 50 m.p.h. on 30 × 5 Tyre loaded against 67-inch Diameter Drum

Tyre Design.

The design of aircraft tyres differs from automobile casings in that the most important feature of an automobile tyre, the heavy long wearing tread, makes this type unsuitable for aircraft use. The heavy tread is not only unnecessary in an aeroplane tyre, due to its relatively small mileage, but it is undesirable because of its weight. Automobile casings are designed to have sufficient flexibility to accommodate low inflation pressures used in balloon tyres, and the tread is of highly compounded rubber to withstand the abrasive effect of hard surface roads. This hard tread necessitates the addition of a breaker fabric and cushion of lively rubber for the protection of the main fabric carcass.

An aeroplane tyre functions in an entirely different manner and the high landing speeds impose higher shock loading than is met with in any other service. The high landing speed starts the wheel rotating at a fast rate, causing loads which necessitate the tread being manufactured from material of high tensile strength and possessing good resistance to abrasion.

The fact that aerodromes usually have soft surfaces forces the use of a flexible tyre with a low inflation pressure, to

prevent the wheels from sinking into the surface. In this connection, the possibilities of balloon tyres, similar to the Goodyear Air Wheel, are of interest. The low mileage of aircraft tyres, combined with low inflation pressures, makes possible the use of a tyre consisting of only the fabric carcass with a plain rubber tread. This insures a tyre of minimum weight, while meeting the general requirements for this class of work.

The smooth tread has always been used because of its small weight and low resistance but, with the use of brake equipment, there is a tendency, in America, to fit non-skid treads, due to the slipping of smooth tread tyres.

Energy Capacity.

With the introduction of balloon tyres, it has been suggested that other means of shock absorbing and springing can be eliminated. In view of this possibility, it is of interest to examine the shock-absorbing capacity of pneumatic tyres in the light of some recent investigations.‡

The hysteresis effect of tyres has been measured on many occasions by loading wheels with gradually applied loads, and measuring tyre deflections during the process of increasing and reducing the load. This method gives results which only approximately represent the capacity of the tyre to absorb energy in a vertical direction. This is due to the slow rate of applying the load, as compared with actual landing conditions.

A study of the manner in which a tyre functions will reveal the fact that even a rapid loading test will not give the true figures since, in landing, the tyre does not remain stationary, but rolls over the ground at a rapid rate. It is essential that energy-absorbing tests should be carried out with a rolling tyre because, during the interval of landing, the tyre may travel a considerable distance along its outside periphery and, it seems reasonable to expect, the energy absorbed due to hysteresis of the tyre carcass will bear some relation to the length of carcass under load. In the case of static loading tests, there is quite a small section of tyre making ground contact, and consequently the true hysteresis effect will not be recorded.

It is difficult to simulate an actual landing condition in the laboratory, but one method which has been successfully used by the B.F. Goodrich Rubber Co. consists of a wheel and tyre mounting which permits vertical wheel movements, sudden application of loads, and a ground effect produced by rotating a large diameter pulley. By allowing the wheel to make contact with the rotating pulley, it has been possible to obtain the first reliable data on the performance of landing wheels under practically identical conditions to those met with in an actual landing.

Fig. 9 records test of a 30 × 5 wheel and, for purposes of comparison, the static test on a non-rotating wheel is also given. The pulley used was 67 in. diameter, and a peripheral velocity of 50 m.p.h. was maintained throughout the test.

The most interesting feature of this investigation is that, whereas the static test shows a characteristic hysteresis loop, for the dynamic test, the loading and unloading curves coincide. This is quite remarkable, for it would indicate that the tyre does not absorb any energy in the vertical direction. This statement is borne out by Mr. H. F. Schippel,§ who states :—" It can therefore be concluded that the efficiency of a rolling pneumatic tyre as an energy dissipater is zero."

On first examining these results, it is difficult to believe that the tyre absorbs no energy because considerable heat must be generated in distorting the tyre, and by compression of air in the tube. The same authority, quoted above, gives the opinion that the whole of this energy loss appears as a net horizontal, or braking, action, and not vertical or shock-absorbing action.

There is little doubt that these results are correct, since the researches and publications have been made by a leading firm of tyre manufacturers, who have everything to lose by such statements.

The aircraft engineer will be interested in these results, because they definitely show that it is not possible to dispense with hydraulic or mechanical shock absorbers solely by tyre replacements.

The above tests were carried out with tyres having inflation pressures of 50 lb. per sq. in., and it would be interesting to obtain comparative reports for balloon tyres.

References.

* Charles J. Cleary, Technologist to U.S. Army Air Corps.
† H. F. Schippel, Design Engineer, The B.F. Goodrich Co., Akron. "Aeroplane Wheels and Tyres," paper read before American Society Mechanical Engineers, October, 1929.
‡ and § H. F. Schippel, "The India Rubber Journal," December, 1929.

TECHNICAL LITERATURE

SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORTS

These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office at the following addresses : Adastral House, Kingsway, W.C.2 ; 120, George Street, Edinburgh ; York Street, Manchester ; 1, St. Andrew's Crescent, Cardiff ; 15, Donegall Square West, Belfast ; or through any bookseller.

THE ELASTICITY OF PINTCH CRYSTALS OF TUNGSTEN. By S. J. Wright, B.A. Work performed for the Department of Scientific and Industrial Research. R. & M. No. 1264. (M. 65.) (15 pages and 7 diagrams.) March, 1929. Price 9*d*. net.

Very little work has hitherto been done on the elastic properties of single crystals of metals. In the case of tungsten, which is the only cubic crystal whose elastic constants have been determined, the previous work of Bridgman based on static tests indicated that the constants satisfied the Isotropic relation. In the present investigation dynamical methods have been employed to redetermine these constants more accurately, and in particular to find out whether the crystals are truly isotropic.

No change of torsional modulus of rigidity with orientation could be observed. The order of accuracy of the results was such that the experiments would have disclosed any variation of as much as one part in 400 over the range of orientations employed. It is concluded that over the whole range of possible orientations the variation of the modulus of rigidity cannot exceed 1 part in 200, and that the material is probably truly isotropic. The values of Young's modulus, the modulus of rigidity, and Poisson's ratio for the material, are given in the report.

Since the only cubic crystal, which has been investigated, has been found to be isotropic within very close limits, it appears to be a matter of importance to find out whether isotropy is

(1) a property peculiar to tungsten crystals ; or
(2) a property of all body centred cubic crystals ; or
(3) a property of all cubic crystals.

It is proposed to carry out further experiments, on the same lines, using cubic crystals of other metals and to determine the type of elastic symmetry which exists, together with the necessary elastic constants.

FULL SCALE MAXIMUM LIFT COEFFICIENT OF R.A.F. 28 SECTION WING. By E. T. Jones, M.Eng., and K. W. Clark, B.Sc., D.I.C. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1269. (Ae. 415.) (2 pages and 2 diagrams.) June, 1929. Price 3*d*. net.

The lift curve of R.A.F. 28 section which has a thickness-chord ratio of 10 per cent. and a centre line camber of 2 per cent., has been determined in the wind tunnel.* The magnitude of the maximum lift coefficient increased with wind speed up to the highest wind speed obtained. Full scale tests were necessary therefore to establish the value of the maximum lift coefficient of R.A.F. 28 section wing.

The lift curve has been determined from 15° to 28° incidence of the biplane wing arrangement of the Atlas aeroplane.

The full scale maximum lift coefficient of the biplane arrangement is 0·495 and occurs at an incidence of 18·0°. There is practically no loss of lift between this value of wing incidence and the maximum incidence obtained, viz., 28·0°.

* R. & M. 1027. Test of two aerofoils, R.A.F. 27 and R.A.F. 28, by A. S. Hartshorn and H. Davies.

WIND TUNNEL TESTS WITH HIGH TIP SPEED AIRSCREWS. EXPERIMENTAL INVESTIGATION OF BLADE TWIST UNDER LOAD. By G. P. Douglas, D.Sc., W. G. A. Perring, R.N.C., and R. A. Fairthorne. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1272. (Ae. 418.) (7 pages and 2 diagrams.) May, 1929. Price 6*d*. net.

The tests were carried out to relate the lift and drag coefficients, determined for an airscrew blade element by an analysis of the thrust and torque grading, to the angle of incidence of the element.

The blade twist under load has been measured on six model airscrews with R.A.F. 27, 28, R. & M. 322 No. 3 blade sections and a specially thin section 0·082C thick.

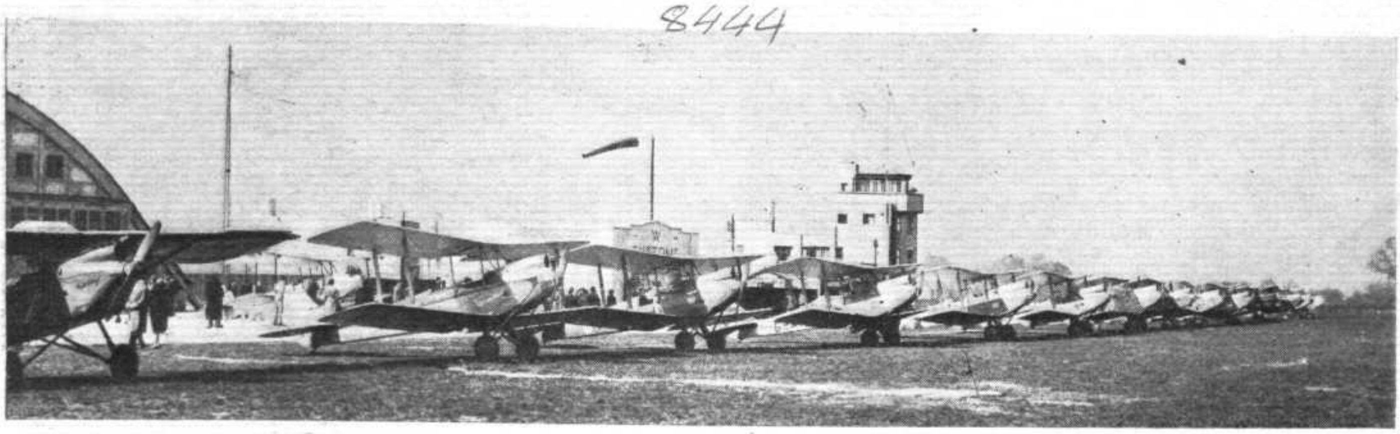
In nearly every case the twist of each airscrew was measured at two pitch settings, at two coefficients of advance for each of these settings and at tip speeds up to 1·3 times the velocity of sound.

For all the airscrews tested the measured twist was found to agree approximately with the calculated centrifugal twist.

PRIVATE FLYING AND CLUB NEWS

THE HESTON TOUR

8444



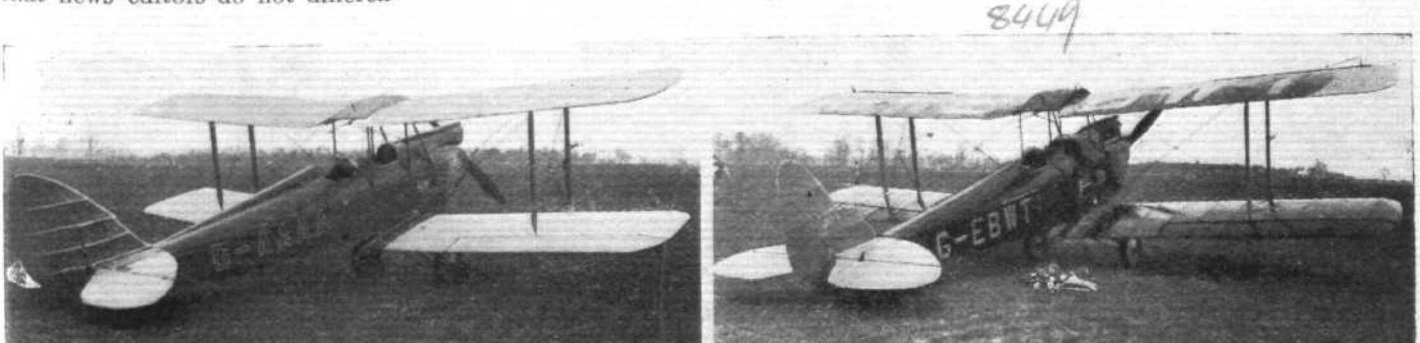
THE LINE UP: A view along the machines just before the departure. (FLIGHT *Photo.*)

THE TOUR which started from Heston on Thursday morning, April 17, merits quite a large amount of thanks from the British Aircraft industry because probably there is nothing which could have been done at the present time which will so successfully bring before all those interested on the continent, the fact that our aircraft are eminently suitable for journeys of comparatively long range.

Few will attempt to deny that the future of aircraft lies in long distance travel and not in such journeys as can be undertaken in a car quite regardless of the weather. There will undoubtedly always be a useful sized market for such machines as can conveniently be used by the private owner, but it is in large machines that big money will be made. However, before we get to the stage when people will look upon travelling by air as the rational way of covering long distances quickly, we shall have to educate them to see that such travel is not the dangerous thing which many of our daily papers would make us believe, that is, if we are to credit the news value they apparently put on crashes, and incidentally it is regrettable that news editors do not differentiate to a far greater extent between commercial and service crashes. Such education can be, and is being, very ably carried out by the many private owners who are undertaking journeys which in some cases have taken them to the other side of the world. The present tour will, undoubtedly show

WAITING FOR THE WORD GO! Despite the bumpy weather our photographer got this view from above. (FLIGHT *Photo.*)

8449

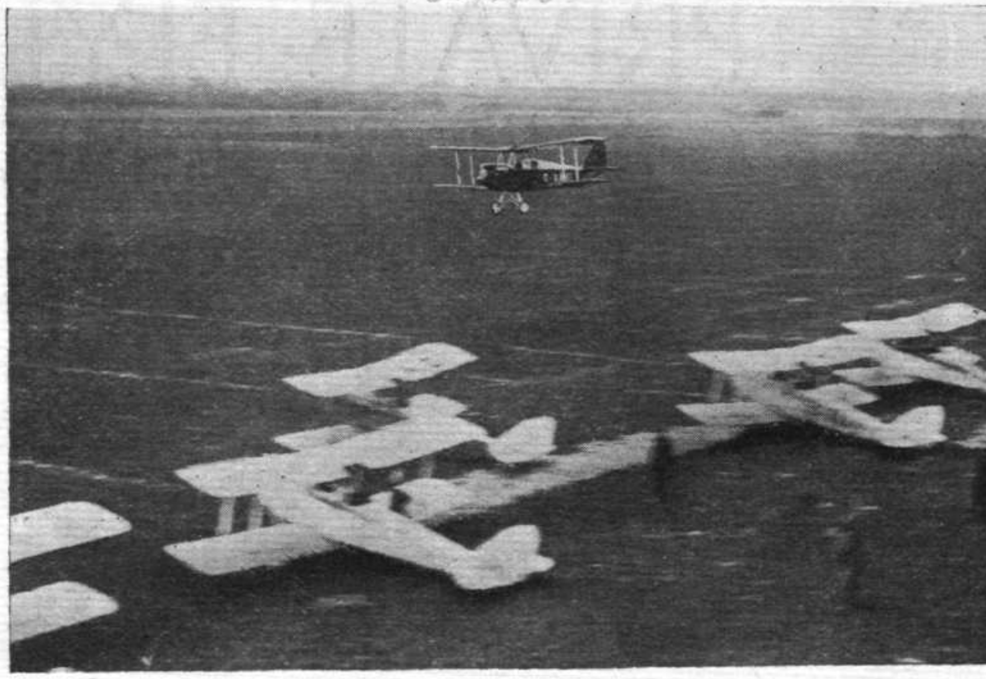


APPROPRIATE LETTERS: The machine on the left belongs to Mr. Ivor McClure, of the A.A., while that on the right is Mr. Runciman's, and is the first private owner's machine fitted with the Amplion wireless gear we described on November 21 last year. (FLIGHT *Photo.*)

that there is little more in such a trip than if it was undertaken by motorcar, and when completed it will have "shown the flag," of reliable British aviation, as it were, and in many places such carefully sown seed may bear good fruit, and even should this fruit prove to be of slow growth the effect of the tour in all countries cannot fail to be good.

As the interest which this occasion has aroused appears to be large we give below a full list of those taking part, with the names of their machines and engines.

At the time of going to press little definite news has been received of the progress of the party and next week we hope to give a full account of their wanderings. Mr. Wills and Mr. Ambler returned on Tuesday and reported that they had had a very good time indeed and apart from a few minor mishaps nearly everybody seems to have adhered to their schedule. The entire party had lunch on board the Graf Zeppelin at Friedrichshafen, and were shown over the Dornier Do. X. The visit to the Wasserkuppe Gliding School had to be cut out owing to the weather.



THE LEADER: Mr. Nigel Norman flying down the line before leading the tour to the Continent. (Flight *Photo.*)

Those going on the longer cruise :—

Pilot.	*Passenger.*	*Aircraft.*	
J. Cantrill	R. A. Williams (Mechanic)	G-AALX	Gipsy Moth.
N. Norman	Miss Norman	G-AAHI	,,
Capt. V. Baker	—	G-EBYK	,,
Lord Douglas Hamilton	—	G-AAKE	,,
J. Chalmers	Mrs. Chalmers	G-AACO	,,
Mrs. Cleaver	D. Cameron	G-AAVY	,,
R. Denman	Dr. Whitehead Read	G-AAVS	Siemens-Klemm.
A. Downes-Shaw	—	G-AALV	Gipsy Moth
H. Selfridge	—	G-AASA	,,
J. Shand	—	G-AAHU	,,

Those who are probably only going until Tuesday are :—

F. Muntz	Mrs. Muntz	G-AATK	Hermes Desoutter.
H. Peake	R. Atcherley	G-AAUU	Gipsy Bluebird
G. Ambler	—	G-AABI	Gipsy Moth
J. Turner	—	G-AALF	,,
J. Bryans	—	G-AAAL	,,
P. Wills	—	G-EBOI	Moth Cirrus II
W. Perkins	—	G-AASY	Gipsy Moth
W. Macpherson	Miss Macpherson	G-EBRT	Cirrus III Moth
W. Runciman	Miss Leatheart	G-EBWT	Cirrus II Moth
Miss Trevelyan	—	G-AAIB	Gipsy Moth
R. Cochrane	—	G-EBRO	Cirrus III Widgeon

THE LEICESTER MEETING

THE LEICESTER CLUB suffered a severe blow on Saturday, April 19, when the weather literally, washed-out their meeting at Desford. At lunch time it snowed hard and pilots who flew up during the morning had to come through snow or rain storms all the way. The wind was very high and gusty and finally the Committee had to regretfully cancel the programme.

A surprising number of spectators turned up in spite of the weather, and some 36 visitors arrived by air.

The A.A. were blessed by many an owner, and had it not been for their prompt help when the machines landed, many would have been blown over in doing so. Mr. Ivor McClure who organises the aviation side of the A.A. deserves the highest praise for the extremely efficient way which he and his men carry out their self-appointed job at these meetings, no ground staff works more willingly than they do whatever the weather, and whatever the owner lacks in the way of cockpit covers and pickets can generally be found by them. On Saturday as the wind increased several machines would have been blown over in the machine park had it not been for those near them holding them down, and the A.A. were round the parking ground quickly helping everyone to fold and picket their machines as soon as the gusts got too bad.

The spectators were not allowed to go away without some entertainment and several pilots gave them most excellent aerobatic shows. Flt.-Lt. Rose threw his orange and green Moth about in the skilful way which marks all his flying, and if the bumpy weather worried him he did not show it ; incidentally he came up during the morning in the Avro Five from Heston with a load of passengers who must have blessed the comfort afforded them by the cabin, for the Moth and Avian which followed him had to endure a dirty trip through snow most of the way.

F./O. Snaith took up one of the club Moths and put up one

THAT GENTLE TOUCH: Miss Slade puts her Moth down at Desford, but the wind nearly takes it off again for her. (Flight *Photo.*)

8596

BATTENING DOWN: Securing the machines at Desford for the night. Mr. Lamplugh, of the B.A.I.G., in the foreground, is evidently shaking with apprehension at what the night may bring. (Flight *Photo.*)

of the finest shows we have ever seen. His inverted spin and inverted falling leaf were magnificent, and the smooth way in which he finished every manœuvre were worthy of the largest audience the field would have held.

Incidentally it was this same officer who pulled off a most perfect forced landing on the aerodrome when the engine of the Comper Swift which he was flying cut-out owing to the rain having got to the fibre bush in the magneto make-and-break and making it stick.

The complete programme with the exception of the R.A.F. display was carried through on Monday, April 21, when the weather was not so bad. A large crowd paid for admission and the whole day was a thorough success. Mr. P. Grey won a message-dropping competition; Mr. J. Tyler won the Desford Grand National in which the pilots had to fold the wings of their machines and do certain other things before being allowed to fly round a short course, and Capt. Broad was given a cup for an aerobatic display.

THE HANWORTH MEETING

NATIONAL FLYING SERVICES held their first meeting at Hanworth Park on Monday, April 21. There was a lack of spectators in the club and more expensive enclosures, and also of visiting machines.

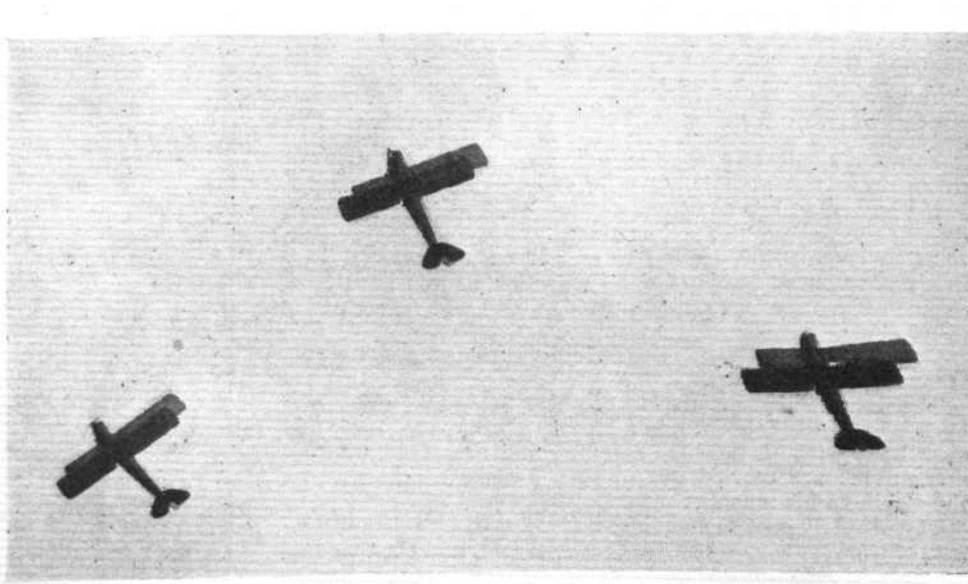
For some reason N.F.S. shows do *not* appeal to the average private owner, and though the 1*s.* enclosure was patronised by some five or six thousand they were for the most part "local," and not habitual air meeting enthusiasts.

Monday's show was peculiar in many ways. First of all there seemed to be a lot of misdirected organisation. Many rules and regulations had been framed which were designed to minimise danger to the pilots and to the public and at the same time to ensure the smooth running of the programme, but these rules were not always carried out, with the result that there was a certain amount of confusion. One pilot who came over in his own aircraft was not given a copy of the rules, which all pilots were supposed to be given when they arrived, until five o'clock and just before he was leaving!

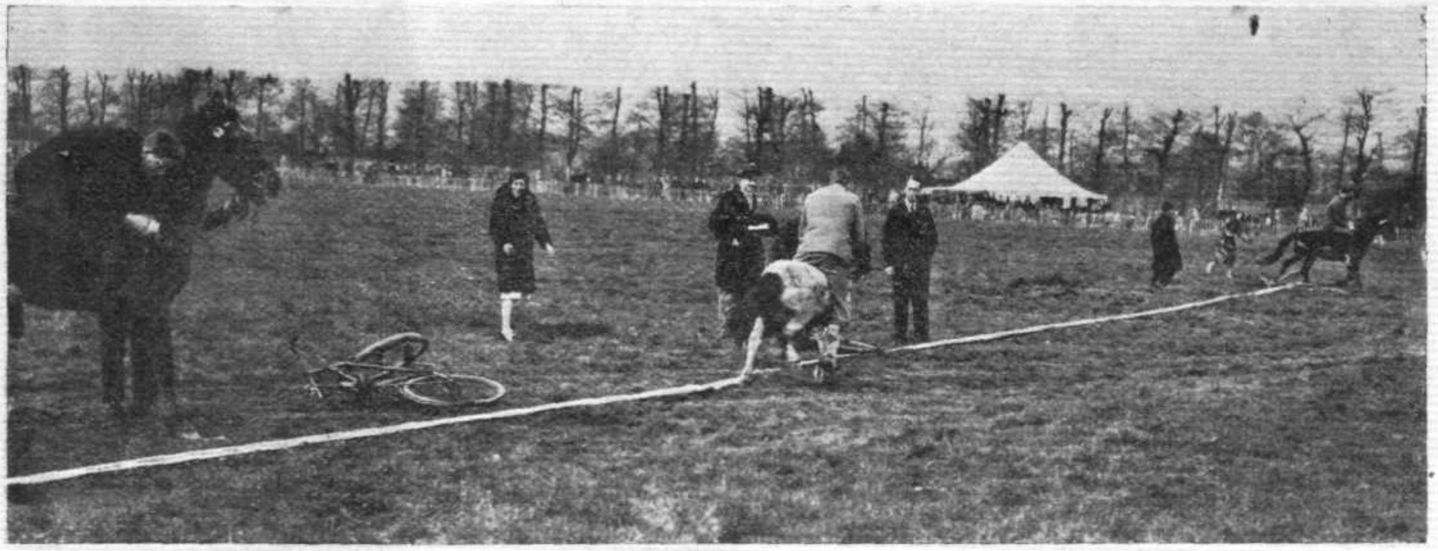
During one of the races it was necessary to fly "one circuit of the aerodrome" according to the programme, but the competitors proceeded to fly round inside the aerodrome, and apparently had not been told where the limits of the circuit were nor where the finishing line was.

During the pageant several machines arrived, and were obviously uncertain as to where they should taxy after landing, and an official to tell them where to go would have saved much delay in getting them clear of the aerodrome.

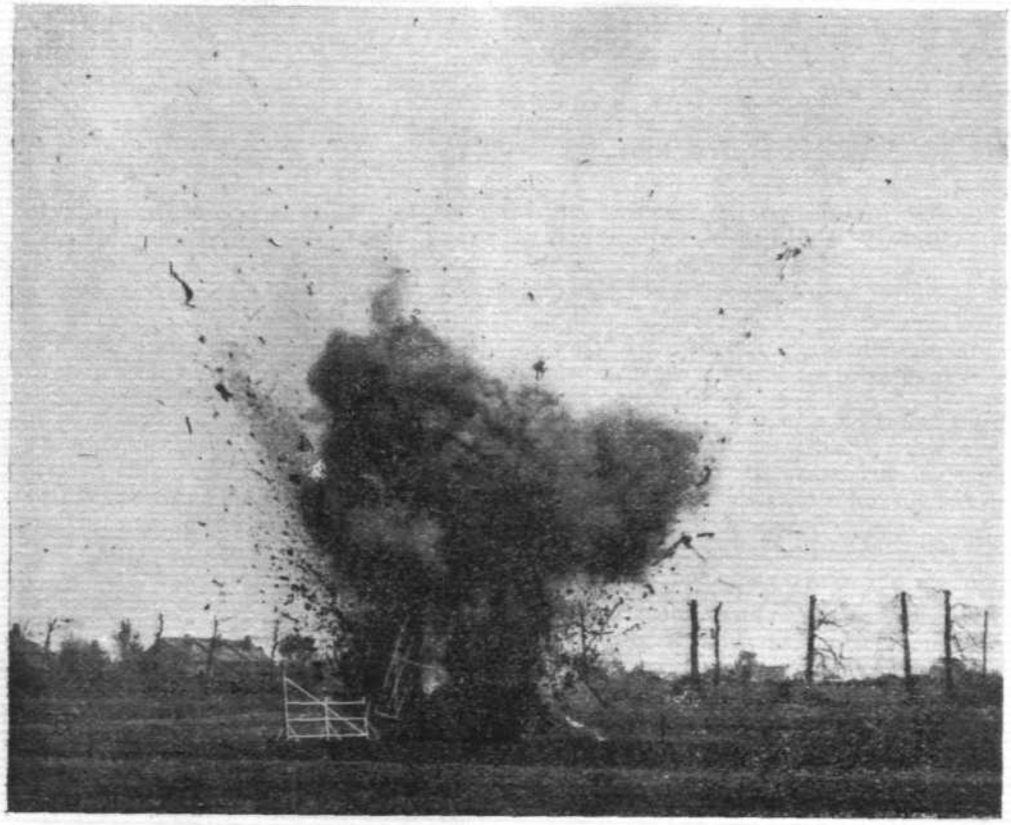
Mr. Tranum failed to put in an appearance, and the end of the programme consequently tailed off somewhat. One would have thought that this could have been avoided by an impromptu crazy flying display by one of the many well-



THEIR LAST APPEARANCE: The N.F.S. Circus, who will not be performing again. (Flight *Photo.*)



THE HUMOROUS SIDE: Capt. Brown on the right and Mr. Edwards in the middle find their mounts have insufficient rudder control during the race. (FLIGHT *Photo.*).



THE FINALE: The level crossing is no more. (FLIGHT *Photo.*)

Flight-Lieut. Schofield then went up and showed everyone that a Desoutter can be stunted in a manner not far short of a Moth.

The "All Forms of Transport" Race was entered by P./O. Edwards, in the Avro Baby Cirrus II, Capt. E. C. Brown and Dr. Fleming in Gipsy-Moths. In this race the competitors had to ride a bicycle 150 yards after first pumping up one tyre; ride a horse over the same distance; drive a car backwards over the same distance; carry their passenger pick-a-back to their aeroplane; then take-off and fly a left-hand circuit of the aerodrome. P./O. Edwards and Capt. Brown took off together, and the former just managed to win by making his circuit as short as possible.

The N.F.S. Circus gave a masterly display of stunting in formation, and later Flight-Lieuts. Wilson and Mackenzie gave another display on their own.

The *finale* was the destruction of a level-crossing by Lieut. Cathcart-Jones.

---

qualified N.F.S. pilots. Those in the 1*s.* enclosure can have seen very little of the pageant, for all the main items were staged up by the more expensive enclosures, where there were very few spectators. In view of the size of the crowd it seems a great pity that they should have been allowed to go away less air-minded than they came. After all, it is the general public to whom we must look to form the main part of the paying "gate" at air meetings, and for any club to allow some 6,000 persons to go away from their meeting in a discontented frame of mind when such could have been avoided is a very bad policy indeed, which will reflect on all other clubs.

Despite the excellence of each individual performance, the programme lacked pep.

The first item was a display of crazy flying and aerobatics by Flight-Lieut. Schofield, in a Moth. He, as usual, delighted everybody with his polished handling of his machine. All his manœuvres are carried out in such a smooth manner that the strain to his machine must be very small.

The usual fly past of machines was followed by a demonstration of the Autogiro by F./O. L. Egglesfield, and then we had an aerial Pool Competition. In this the competitors had to drop flour bags into marked circles on the ground. Three took part, and it was won by P./O. H. Edwards, in an Avro Baby.

THE WINNERS: Mr. H. Edwards and his passenger, Mr. N. Thompson, who won both competitions. (FLIGHT *Photo.*)

MR. BUTLER'S FLIGHT TO CAPE TOWN

ON March 20 last, Mr. A. S. Butler, chairman of the Aircraft Operating Co., Ltd., accompanied by Mrs. Butler and a mechanic, Mr. Millyard, left Heston Aerodrome in the Gloster AS 31 machine (Bristol "Jupiter") for South Africa. Cologne was reached after 2½ hours' flight, and on the following day they proceeded to Vienna. After stops at Belgrade and Salonika, Athens was reached on the 23rd. They had two days' rest at Athens, and on March 25 a direct flight across the Mediterranean was made to Sollum on the North African coast.

Shortly after leaving Sollum on March 26, an oil tank broke, but Mr. Butler was able to make a satisfactory landing, and the spare oil tank which he was carrying was fitted, and on the 27th he arrived at Aboukir. As it was felt that the aluminium oil tanks might give trouble at a more inaccessible place, it was decided to have special oil tanks made of steel. This was made possible by the valuable assistance of the Royal Air Force at Aboukir in the remarkably short space of three days. These steel tanks were fitted on March 30, and Khartoum was reached on March 31.

The party left Khartoum on April 1 and reached Mongalla on April 2, the aerodrome at Juba being used. Here tyre trouble was experienced, but Mr. Butler was able to leave Juba on April 5, reaching Kisumu on the same day. He arrived at Tabora on April 6, where a short delay of one day occurred owing to the wet state of the aerodrome. He was, however, able to get away from Tabora on the 7th, and arrived at Broken Hill on the same day. Broken Hill is the main base of the Aircraft Operating Company's expedition in connection with the survey of 63,000 sq. miles, which is being carried out for the Government of Northern Rhodesia. Mr. Butler spent a little time inspecting the organisation there and then proceeded to Bulawayo, which he reached on April 11. Bulawayo is the base which the Aircraft Operating Co., Ltd., has maintained for several years now in connection with the very considerable amount of survey work that has been done in that area.

On leaving Bulawayo the party was joined by Maj. Cochran-Patrick on April 12. They arrived at Pretoria, from where, after two days' stop, they proceeded to Cape Town, which was finally reached on April 15.

The 8,000 miles was covered in 74 hours' flying time, which gives an average flying speed of 108 m.p.h. We feel that the very highest credit is due to Mr. and Mrs. Butler for the particularly fine performance in reaching Cape Town in the space of 25 days, when it is realised that the flight was merely a normal business journey with the maximum precautions for safety, and we feel that the flight is notable for the fact that no serious untoward incidents were encountered, thus proving the increasing value and safety of aerial transport. We think that this performance is even more impressive when it is realised that the aircraft is not merely a new type, but is the first of its type and had only undertaken relatively short tests in this country. The pilot had therefore had only a limited amount of experience on the aircraft before setting forth on his long journey over two continents, including the crossing of what was once known as "Darkest Africa."

◈ ◈ ◈ ◈

AIRISMS FROM THE FOUR WINDS

The Prince of Wales

THE Prince of Wales left Khartoum at 5.30 a.m. on April 16 on his flight to Cairo. A stop for lunch was made at Wadi Halfa, where he was entertained by Sir Herbert Jackson, Governor of the Province. He reached Assuan in the evening in company with three other 'planes, a second squadron arriving shortly after. After tea the Prince visited the Assuan Dam. He reached Cairo on April 17.

Prime Minister Flies Home

MR. RAMSAY MACDONALD flew from Hendon to his home at Lossiemouth on April 16. He stated that he had had a "wild but thoroughly enjoyable flight," much wind and rain being encountered during the journey.

Australia-England Flight Resumed

MR. DAVID SMITH and Lieut. Shiers, who are making a flight from Australia to England in a Ryan monoplane and who were brought down with engine trouble near Wyndham, have resumed their flight, having effected the necessary repairs. They left Wyndham on April 20 and arrived safely at Bima, Dutch East Indies.

England-Australia Flight Fails

MR. PARKERSON left Croydon early on April 21 on a solo flight to Australia, but crashed at Arquel, in the Somme Department, when his machine hit a tree while flying through fog. The machine caught fire, but the pilot escaped with slight burns.

Piper and Kaye Home

FLYING OFFICERS PIPER AND KAYE, who recently flew from Croydon to Australia in a Desoutter cabin monoplane ("Cirrus Hermes"), arrived in Auckland by steamer on April 15. Several aeroplanes met the steamer as it entered the harbour.

Graf Zeppelin

THE *Graf Zeppelin* left Friedrichshafen at 2 p.m. on April 15 for Seville, and arrived there the following afternoon. The airship's arrival was watched by the King and Queen of Spain, and an enormous crowd, while many Spanish aircraft flew to Seville for the occasion. The *Graf Zeppelin* set out in the evening on the return flight. It is stated that the airship will leave Friedrichshafen at 7 a.m. on April 26 for a flight over the North Sea. Permission has been given by the Air Ministry for the *Graf Zeppelin* to land at Cardington, so a stop will be made there before the airship returns home. Capt. Lehmann will be in command, but Dr. Eckner, who is at present in England, will take over for the return flight. On April 22 the airship made a flight over the Rhineland with 16 passengers, landing at Bonn and returning to Friedrichshafen in the evening.

Semi-rigid Airships for Russia

IT is reported that the Soviet Government has decided to construct two small semi-rigid airships this year, for training purposes.

Long-distance Seaplane Record

THE French pilot, Jean Mermoz, established a world's record for long-distance flight by seaplane, at Marseilles, on April 12, when he covered 4,345 km. (2,694 miles) in a closed circuit. He was in the air for 30 hrs. 25 mins., and the machine carried a load of 4,000 lbs.

***Not* Prevost!**

WE are informed that M. Prevost, the famous French pilot, who was reported in our issue of April 11 as having been killed in an air accident, is, in fact alive and well! It appears that the pilot involved in the fatal accident in question was another bearing the same name, so that it was a case of mistaken identity on the part of the correspondent who sent out the news item. We are glad to learn that the French pioneer pilot, M. Prevost, of Schneider fame, is still with us, and that he will be seen at the Vincennes Air Meet at Whitsuntide, flying an old 1911 Deperdussin monoplane, which has just been rebuilt!

Two New Caterpillars

FLYING OFFICER K. S. DRAKE and Pilot Officer J. Heber Percy of the Royal Air Force collided recently whilst engaging in a mock fight over Chichester at an altitude of 3,000 ft. Both officers jumped and saved their lives with their Irvin Air Chutes, which are standard equipment in the Royal Air Force. They make the International Caterpillar Club membership over 260, each member having saved his life with an Irvin Air Chute.

King's Cup Air Race

THE race for the King's Cup this year, which takes place at Hanworth on July 5, is open to any type of *bona-fide* civil aircraft. The aircraft, including the engine or engines, must have been entirely constructed in the British Empire. For the purposes of the race, a *bona-fide* civil aircraft is an aircraft which was originally designed and subsequently constructed for use in civil aviation activities. In any question regarding the eligibility of any aircraft, the decision of the Royal Aero Club shall be final.

Caproni Aircraft in Bulgaria

IT is announced that the Italian firm of Caproni has acquired a large aeroplane factory installed in the last few years in the town of Kazanlik by a Czechoslovak aviation firm. The incidental concession for the exclusive supply of aeroplanes to the Bulgarian State has also passed to the Italian firm.

THE NAVAL CONFERENCE AND AIRCRAFT

WE give below extracts from the clauses in the Naval Treaty (which was signed at St. James's Palace on April 22), which affect Aircraft Carriers, etc. They are as follow :—

PART I : Article 3

1. For the purposes of the Washington Treaty, the definition of an aircraft carrier given in Chapter II, Part 4 of the said Treaty, is hereby replaced by the following definition :—

The expression "aircraft carrier" includes any surface vessel of war, whatever its displacement, designed for the specific and exclusive purpose of carrying aircraft, and so constructed that aircraft can be launched therefrom and landed thereon.

2. The fitting of a landing-on or flying-off platform or deck on a capital ship, cruiser or destroyer, provided such vessel was not designed or adapted exclusively as an aircraft carrier, shall not cause any vessel so fitted to be charged against or classified in the category of aircraft carriers.

3. No capital ship in existence on the 1st April, 1930, shall be fitted with a landing-on platform or deck.

Article 4

1. No aircraft carrier of 10,000 tons (10,160 metric tons) or less standard displacement mounting a gun above 6·1-in. (155 mm.) calibre shall be acquired by or constructed by or for any of the High Contracting Parties.

2. As from the coming into force of the present Treaty in respect of all the High Contracting Parties, no aircraft carrier of 10,000 tons (10,160 metric tons) or less standard displacement mounting a gun above 6·1-in. (155 mm.) calibre shall be constructed within the jurisdiction of any of the High Contracting Parties.

Article 5

An aircraft carrier must not be designed and constructed for carrying a more powerful armament than that authorised by Article IX or Article X of the Washington Treaty, or by Article 4 of the present Treaty, as the case may be.

Wherever in the said Articles IX and X the calibre of 6 in. (152 mm.) is mentioned, the calibre of 6·1 in. (155 mm.) is substituted therefor.

PART II : Article 8

Subject to any special agreements which may submit them to limitation, the following vessels are exempt from limitation :

Naval surface vessels not specifically built as fighting ships which are employed on fleet duties or as troop transports or in some other way than as fighting ships, provided they have none of the following characteristics :

Are fitted to receive aircraft on board from the air ;

Mount more than one aircraft-launching apparatus on the centre line ; or two, one on each broadside ;

If fitted with any means of launching aircraft into the air, are designed or adapted to operate at sea more than three aircraft.

Article 9

The rules as to replacement contained in Annex I, to this Part II, are applicable to vessels of war not exceeding 10,000 tons (10,160 metric tons) standard displacement, with the exception of aircraft carriers, whose replacement is governed by the provisions of the Washington Treaty.

Article 10

Within one month after the date of laying down and the date of completion respectively of each vessel of war, other than capital ships, aircraft carriers and the vessels exempt from limitation under Article 8, laid down or completed by or for them after the coming into force of the present Treaty, the High Contracting Parties shall communicate to each of the other High Contracting Parties the information detailed below. . . . .

The information to be given in the case of capital ships and aircraft carriers is governed by the Washington Treaty.

Article 11

Subject to the provisions of Article 2 of the present Treaty, the rules for disposal contained in Annex II, to this Part II shall be applied to all vessels of war to be disposed of under the said Treaty, and to aircraft carriers as defined in Article 3, viz. :—

ANNEX II, SECTION I.—*Vessels to be scrapped*

A vessel to be disposed of by scrapping, by reason of its replacement, must be rendered incapable of warlike service within six months of the date of the completion of its successor, or of the first of its successors if there are more than one. It shall be considered incapable of warlike service when there shall have been removed and landed or else destroyed in the ship : all aircraft cranes, derricks, lifts and launching apparatus. All landing-on or flying-off platforms and decks, or alternatively all main propelling machinery.

SECTION II.—*Vessels to be Converted to Hulks*

A vessel to be disposed of by conversion to a hulk shall be considered finally disposed of when the conditions prescribed above in Section I, have been complied with, and when the following have been effected :—

Removal and breaking up of all aircraft lifts, and the removal of all aircraft cranes, derricks and launching apparatus.

SECTION IV.—*Vessels Retained for Experimental Purposes*

The United Kingdom is allowed to retain, in their present conditions, the monitor *Roberts*, the main armament guns and mountings of which have been mutilated, and the seaplane-carrier *Ark Royal*, until no longer required for experimental purposes.

SECTION V.—*Vessels Retained for Training Purposes*

In certain vessels, other than capital ships, retained by France, Italy and Japan, the following is to be carried out—removal of all aviation facilities and accessories.

Article 16 (*Part III*) contains the following :—

Not more than 25 per cent. of the allowed total tonnage in the cruiser category may be fitted with a landing-on platform or deck for aircraft.

PART V : Article 23

The present Treaty shall remain in force until December 31, 1936, subject to the following exception :—

The provisions of Articles 3, 4, and 5, and of Article 11 and Annex II to Part II, so far as they relate to aircraft carriers, shall remain in force for the same period as the Washington Treaty.

British Science Guild and Sir Samuel Hoare

THE Rt. Hon. Sir Samuel Hoare, Bart., G.B.E., C.M.G., LL.D., M.P., has accepted nomination as president of the British Science Guild in succession to the Rt. Hon. Lord Melchett, P.C., D.Sc., F.R.S.

Death of Mr. P. A. Ralli

THE British Aircraft Industry has suffered a severe loss by the death, which occurred on April 17, of Mr. Pandia Antonio Ralli, chief aerodynamic expert and technical engineer of the Fairey Aviation Co. Mr. Ralli, who was only 41 years of age, had specialised in airscrew design, and was responsible for the high-speed metal airscrews used so successfully in the last two Schneider Trophy Contests. He also played a considerable part in the design of the Fairey (Napier) long-distance monoplane.

Death of Mr. Robert Coan

WE regret to announce the death of Mr. Robert William Coan, whose name is so well known in connection with aluminium castings for the motor and aircraft industry. Mr. Coan died at his home at Canonbury on April 14, at the age of 66 years.

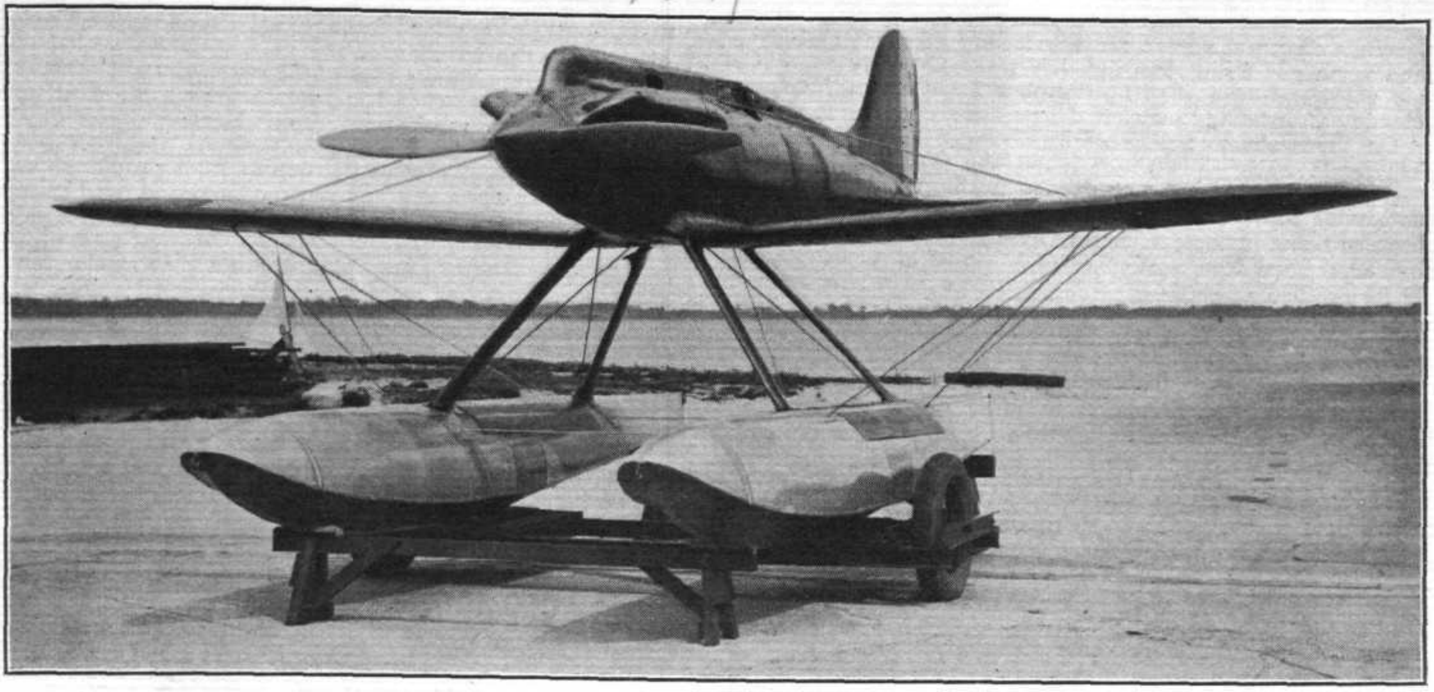
French Aviation Pioneer Killed

A SERIOUS blow to aviation is caused by the death in an aeroplane accident of Count de la Vaulx, who was one of the founders of the Aero Club of France and a pioneer of early flying. He, together with the pilot and two other passengers, were killed on April 18, when a machine of Canadian Colonial Airways flying between Albany and New York, crashed in the fog into some high-tension cables near Jersey City. The pilot, John Falway, apparently failed to see the wires, and the machine burst into flames, all the occupants being instantly killed.

The R.A.F. Accident at Worthy Down

DURING the inquest on F./O. E. W. White and P./O. J. Pratt, who were killed when landing at Worthy Down after a night flight on March 24, Wing-Commander Norton stated "The 58th Bomber Squadron has done 2,200 hours' night flying during the last four years, and this is the only serious accident we have had."

7549



THE GLOSTER VI: The neat cowling of the Napier engine enhances the dainty lines of the aircraft. (Flight *Photo.*)

THE SCHNEIDER TROPHY—1929

By FLIGHT-LIEUT. H. R. WAGHORN, A.F.C., R.A.F.

A lecture before the Westland Aircraft Society, Yeovil Branch of the Royal Aeronautical Society, on February 14, 1930

(*Continued from page* 448.)

WITH the arrival of the S.6 our hopes had risen considerably, only to be immediately lowered to the depths when Sqd.-Ldr. Orlebar started his initial tests in Southampton Water. The S.5 in her take-off had been so straightforward that we had assumed that her elder brother would also prove himself equally docile while being broken in. We were therefore very surprised to see the behaviour of the S.6 on her first test. The S.6 behaved much as a horse refusing a fence. She sat on her tail and it seemed as if no amount of coaxing would get her forward. Furthermore, she dug her left wing into the water and, not content with so much mischief, began a gigantic porpoising. Time and again the Sqdr.-Ldr. tried, and although he had overcome the porpoising she still continued to dig her left wing in and to swing viciously to the left. To the rest of us in the *Seacar* alongside it was a heartrending, although impressive, sight. From the *Seacar* we had a close-up of the whole proceedings, and a very good view it was, not that one could see much of the pilot and fuselage, as most of the time they were enclosed in a whirl of spray. After about a half an hour of this we returned to Calshot in a rather dejected frame of mind, as it certainly had not been a good beginning. The main trouble was the wing digging business, and due without doubt to the enormous torque effect of the slow revving engine and propeller. Mitchell's first move was, therefore, to shift nearly all the petrol into the starboard float and to put in hand the immediate construction of a new and larger petrol tank for this float. The result of this was in the end satisfactory, though there were a good many anxious trials before she got safely into the air. To start with, it was a peculiarly delicate task for Sqd.-Ldr. Orlebar. He was swinging, he knew, and his left wing wasn't very far from the water, and he couldn't tell how much owing to the mass of spray enveloping the fuselage. He found out subsequently that a lot of the initial resistance to any acceleration was in part due to the very smooth, almost oily state of the water on which the first taxying trials took place. The surface of the water as viewed from the possibilities of high-speed flying is—"Glassy," which is, of course, dangerous, because the pilot cannot judge his height for landing even if the floats would leave the water, which is doubtful; "oily," "rippled," "slight chop," and "slight swell"; the latter prohibits high-speed flying in that it tends to throw the machine off badly in the take off before flying speed has been reached; it also strains the machine.

The difference in behaviour in the S.6 when she passed from an oily to a rippled patch was most interesting. If an oily sea she careers in a vicious circle like a kitten chasing its tail, but as soon as she got on to the faintest ripple she could be got on to her step and made to accelerate. I was once watching Atcherley trying to take her off. The sea was oily and the machine obstinate. She never looked like even getting on the step. Atcherley shouted to me that he was packing up. We had, however, noticed a patch of rippled water in the distance, and got him to try once more over on that particular bit. The result was magical and he got off on the first attempt. The trouble was that the drag of the floats was just about counter-balancing the thrust. The nose of the machine coming out very high and tail of the floats digging right into the water setting up a very high resistance. The torque effect is greatest at slow revs. We had therefore to fit a faster revving propeller with more power for the take off. This also gave more power for the top speed; but we already had more power than specification, and therefore more heat to dissipate than the original radiators were designed for. Hence it was going to be necessary to throttle down to keep the water cool. A very slight increase in wind by about 4 m.p.h. made the difference; whether it was chiefly the increased control given to the rudder or chiefly the surface of the water affecting the floats I am not prepared to say—perhaps a combination of both, but certain it was that provided you kept the machine into, or slightly to right of the wind you could get her on to the step. If she once got to the left of the wind it was hopeless. (I will describe her take off with full load more fully later on.) Whilst discussing these difficulties it is perhaps easy to assume that the S.6 had a bad take-off. Actually this was not the case, provided one got her into the wind and on her step she accelerated like the proverbial gun. The S.6 appeared to stall about 3 m.p.h. slower than the S.5, but air speed indicators are not infallible at such a speed. However, it can be taken that she stalled in the region of 95 and was certainly no faster in this than the S.5. She was also extraordinarily stable at the stall. The S.5 would quiver at the stall and flick over either side at the slightest provocation. The S.6 showed no tendency to drop either wing, but would sink on an even keel. On one such occasion while testing the stalling speed, I found the machine on an even keel sinking at about 87 m.p.h. When one considered the behaviour of her elder brother at a similar speed it is all the more interesting, especially when you realise the extra top speed of the S.6.

While flying she gave me the feeling of great stability, and when not flying low the slow revs. of the engine gave me the impression that I remember I got when I flew a Horsley after having just left the seat of a Gamecock.

On turns she was delightful. Perhaps she was a little heavier laterally than the S.5 and the Glosters, but then she was a much bigger and heavier machine. There was no noticeable torque effect against a left-hand turn which had been so tiring in the S.5, and, generally speaking, gave me a feeling of great trust and confidence—and I never had cause to change my opinion.

The Glosters arrived a few days after the first S.6, but unlike the latter which arrived by sea, already erected, they had to be assembled, and it was not for many days that the first one was ready for the air. Misfortune dogged the Gloster VI from its first flight, when Sqdn.-Ldr. Orlebar had to execute a forced landing when she had barely risen 20 ft. The landing was perfect, but it showed that the minimum area for high-speed flying should be 3 miles long. The Gloster had been forced to land owing to some petrol installation trouble; bad weather had put off this last flight for a bit, so that when she was tested again, and it appeared to be cutting out badly in turns, Glosters found themselves with only a few days to go and a tricky little problem before them. They had also to put on more oil coolers, and it was time to put in the racing engine. Full praise must be given to the mechanics and staff of the Gloster Co. who, as one paper had it, "worked till they dropped" to get their machine in for the race. Right up to the last minute was the work carried on and the machine was tested as late as Friday morning. The same trouble again:—We were all desperately sorry that the Gloster VI couldn't fly in the race. It was our one great disappointment.

However, things were beginning to hum. The Italian team started to arrive shortly after the S.6 had done her trials. They brought with them a varied collection of seaplanes, including Bernardi's old "Record" Macchi, which had been converted into a training machine by giving her more wing surface, the M.67 which they raced, and the twin-engined Savoia. They also brought a small Fiat seaplane, whose superb finish excited everyone's admiration. It was on this machine that only recently Dal Molin lost his life. The Italians also brought with them two very important gentlemen. Meanwhile, everyone was awfully busy, and mechanics worked on the machines until late hours; in fact, frequently all night. The Italians, too, found they were even more pressed for time.

In order to simplify starting and to avoid taxying long distances and oiling plugs up, all the machines were mounted on pontoons, on a sliding platform, which is wound up and down on a winch.

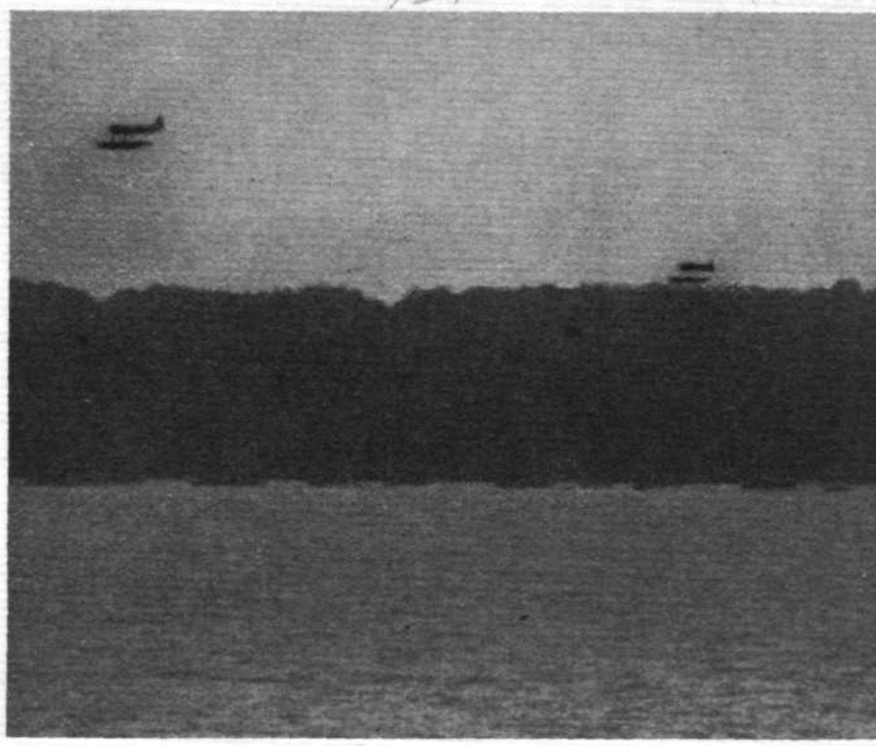
We now come to the Navigability Trials, and the chief thing abort September 6 was that it was my birthday, and although, of course, one felt that it should have been September 7 one couldn't help feeling that it was an obviously most patent omen and that coupled with the cats, mice, elephants, and other harbingers of luck that one received, ought to do *some good.*

The other thing that concerned me on September 6 was the extraordinary perfect weather. Surely it could not be repeated two days running! However, miracles do happen occasionally. About the trials themselves there is very little to say. All machines did their three landings and take-offs successfully and taxied the required distance. They were then moored up to buoys off Calshot for 6 hours, and it was with considerable relief when our mechanics were able to pounce upon our machines and rush them off to the hangars to be tied up for the morrow.

It was with rather mixed feelings that I took my first look at the sea on the morning of the race. After a period of training made up of a series of disappointments, I fully expected that the weather King would have some card up his sleeve, which he would produce on that memorable day. It did not require much to cause a postponement, which would be a source of disappointment to thousands of people. The slightest swell or white horse on the one hand and dead calm on the other were the limits that bounded our capabilities.

The day was unique, a deep blue sky of a type rarely seen in this country coupled with an amazingly good visibility. At the time it was blowing 10 miles an hour, and all was bustle on the tarmac. Some machines were already on the pontoons, while others were black with mechanics using the

9571.



THE THRILL OF THE RACE: Flt.-Lt. Waghorn overtaking Warrant Officer Dal Molin off the Cowes coast. (FLIGHT *Photo.*)

last minute for finishing touches. The machine that I was to fly N.247—was not out yet. Only 8 hours before, one of the Rolls Royce mechanics noticed a small bit of metal on the electrode of one of the plugs; uneasy, they removed the block to find a seized piston and hopelessly scored cylinder. What bad luck! No one considered it possible to be able to change the cylinder block of this particular engine in the time left. Under ordinary conditions Rolls wouldn't undertake it while in the machine, and it was midnight before the race! The story of how that block was changed, how their specialists, by chance in Southampton, were woken by police, is well known. Suffice it is to say that these mechanics did it, and by so doing saved the Trophy.

It was about 10.30 on Saturday morning when 247 came out of the hangar and had her final run-up. Soon after this she was put on her pontoon and joined the queue of shipping which was still emerging in one long stream from Hamble river and Southampton Water. She had about two miles to go to the place that had been decided on for our take-off point. This was between Lee-on-Solent and Calshot, and was so chosen because of the wind which was S.E. Here were already anchored the big pontoon with the three Macchis and our other pontoons with Greig's and Atcherley's machines on board. There was also the official starting-ship—the "Medea."

(*To be concluded.*)

Focke-Wulf Works Rebuilt

THE Focke-Wulf aircraft works at Bremen, which were destroyed by fire last autumn, have now been completely rebuilt, the opportunity having been taken to enlarge and modernise the new factories. Several new types are in course of construction, among which the "Sperber" (Sparrowhawk) A.33 and the "Bussard." The former is a taxiplane with accommodation for pilot and three passengers, and fitted either with a 100-h.p. Siemens engine or a 150-h.p. Walter. The "Bussard" is a commercial machine for two pilots and five to six passengers, and will be fitted with a Junkers L.5 engine. It is similar to, but larger than, the "non-spin" *Habicht.* It is believed that this firm also intends to continue the development of the tail-first machine.

THE ROYAL AIR FORCE

London Gazette, April 15, 1930.

General Duties Branch

The follg. Pilot Officers are promoted to rank of Flying Officer :—H. P. Fraser, G. J. C. Paul (March 7) ; A. F. P. Anning, D. S. McDougall, C. M. Champion de Crespigny, H. A. Fenton, J. S. Shakespeare, C. C. C. Manson, C. Ray, G. O. St. J. Morris, A. F. Powell, A. L. Brain, K. W. Pell, D. F. Satchwell (March 14).

Group Capt. U. J. D. Bourke, C.M.G., is placed on retired list at his own request (April 13) ; Lt. C. R. V. Pugh, R.N., Flying Officer, R.A.F., ceases to be attached to R.A.F. on return to Naval duty (April 1) ; Flight-Lieut. W. F. R. Gough relinquishes his short service commn. on completion of service (April 11) ; Flight-Lieut. H. J. Gearing is transferred to Reserve, Class C (April 1) (substituted for *Gazette*, April 1) ; Flying Officer B. C. Mason is transferred to Reserve, Class A (Dec. 9, 1929) (substituted for *Gazette*, Dec. 17, 1929).

Stores Branch

Flight-Lieut. T. A. G. Hawley is placed on retired list at his own request (April 5).

RESERVE OF AIR FORCE OFFICERS

General Duties Branch

The follg. are granted commns. in Class AA (ii) as Pilot Officers on probation :—C. H. Barnes (March 28) ; R. A. C. Barclay (March 29) ; R. Edwards, C. M. Scrutton (April 1). The follg. Pilot Officers on probation are confirmed in rank :—J. C. E. Luard, M. Spurway (April 3) ; R. F. Bulstrode (April 5) ; E. A. M. Norie, H. R. A. Edwards (April 15).

The follg. Flying Officers are transferred from Class A to Class C :—L. W. Beck (Dec. 12, 1929) ; C. P. Vines (March 4). Flying Officer J. C. Jeffrey, M.C., is re-employed with the Regular Air Force for a further year (April 16).

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the Royal Air Force are notified :—

General Duties Branch

Group Captain E. M. Murray, D.S.O., M.C., to Station H.Q., Heliopolis, to command, 29.3.20.

Wing Commander E. R. Manning, D.S.O., M.C., to Station H.Q., Hornchurch, to command, 1.4.30.

Squadron Leaders : E. R. Pretyman, A.F.C., to No. 216 Sqdn., Middle East, 29.3.30. M. Moore, O.B.E., to No. 208 Sqdn., Middle East, 29.3.30.

Flight Lieutenants : C. B. Riddle, to H.Q., Iraq Command, 29.3.30. C. A. B. B. Wilcock, A.F.C., to Armoured Car Wing, Iraq, 29.3.30. J. R. Bell, D.F.C., to No. 30 Sqdn., Iraq, 29.3.30. D. D'A. A. Greig, D.F.C., A.F.C., to No. 216 Sqdn., Middle East, 29.3.30. S. N. Webster, A.F.C., to No. 84 Sqdn., Iraq, 29.3.30. N. Carter, to Aircraft Depot, Iraq, 29.3.30. P. M. McSwiny, to R.A.F. Base, Malta, 27.3.30. R. St. H. Clarke, A.F.C., to H.Q., R.A.F., Middle East, 27.3.30. M. Wiblin, to No. 607 Sqdn., Usworth, 17.3.30. C. L. Falconer, to No. 608 Sqdn., Thornaby, 17.3.30. R. V. M. Odbert, to R.A.F. Depot, Middle East, 27.3.30.

Flying Officers : M. J. Du Cray, to No. 84 Sqdn., Iraq, 29.3.30. J. H. Edwardes Jones, to No. 4 Flying Training School, Middle East, 29.3.30. N. F. V. Henkel, to No. 55 Sqdn., Iraq, 29.3.30. C. P. Hanlon, to No. 30 Sqdn., Iraq, 29.3.30. G. N. Coward, to H.Q., R.A.F., Transjordan and Palestine, 27.3.30. A. P. Bett, to No. 4 Flying Training Schl., Middle East, 27.3.30. W. D. J. Michie, to No. 208 Sqdn., Middle East, 27.3.30. J. R. H. Pott, to No. 4 Flying Training Schl., Middle East, 27.3.30. F. R. Balfour, to No. 208 Sqdn., Middle East, 27.3.30. R. David, to No. 32 Sqdn., Kenley, 19.3.30. J. Addison, to R.A.F. Depot, Uxbridge, 17.3.30. K. G. Vandyck, to No. 100 Sqdn., Bicester, 24.3.30. P. G. Lucas, to No. 22 Sqdn., Martlesham Heath, 23.3.30.

Pilot Officers : A. C. Larmuth, to No. 33 Sqdn., Eastchurch, 1.4.30. W. I. H. Burke, to No. 204 Sqdn., Mount Batten, 17.3.30. L. Crocker, to No. 204 Sqdn., Mount Batten, 17.3.30. F. A. McNeill, to No. 55 Sqdn., Iraq., 29.3.30. The undermentioned are all posted to R.A.F. Depot, Uxbridge, on appointment to Short Service Commns., with effect from 14.3.30 :—L. H. Anderson, W. A. A. Ashcroft, E. G. Barter, G. Burdick, N. Daunt, A. P. Glenny, W. Halmshaw, T. King, W. E. L. Lewis, T. J. MacDermot, D. M. T. Macdonald, R. I. G. MacDougall, B. J. McGinn, P. H. Maxwell, R. T. S. Morris, J. C. F. Peacock, G. B. Pierpoint, W. A. Richardson, W. A. J. Satchell, H. A. Simmons, L. Sloman, E. C. Van Oppen, A. W. Vincent, R. G. Wilde, and J. D. Woodland.

Stores Branch

Flight Lieutenant W. G. MacD. Nicholl, to Central Supply Depot, Iraq, 29.3.30.

Flying Officers : C. M. P. Hartley, to R.A.F. Depot, Middle East, 29.3.30,. H. W. Penney, to Aircraft Depot, Iraq, 29.3.30.

Accountant Branch

Flying Officers : J. M. Hopkins, to H.Q., Iraq Command, 29.3.30. R. Trippett, to H.Q., Iraq Command, 29.3.30. T. P. E. Campbell, to No. 45 Sqdn., Middle East, 27.3.30.

Medical Branch

Flight Lieutenant L. I. Hyder, to R.A.F. Practice Camp, Sutton Bridge, 26.3.30.

Flying Officers : P. J. Nyhan, to R.A.F. Practice Camp, Catfoss, 26.3.30. J. Murphy, to R.A.F. Practice Camp, North Coates Fitties, 26.3.30.

NAVAL APPOINTMENTS

The following appointments were made by the Admiralty on April 8 :—

Lieut.-Commrs. (Flt. Lieuts., R.A.F.).—F. W. H. Clarke and A. G. Elliot, to *Glorious* (April 15 and 22 respectively).

Lieuts. (F./O., R.A.F.).—G. W. Dennis, J. F. Burroughs, J. P. G. Bryant, J. B. Heath, D. W. Mackendrick, D. R. C. Hodson, J. W. M. Healing, F. G. Wynne, E. J. E. Burt, H. P. Madden, M. Cursham, C. A. R. Gibb, J. E. Burstall, P. Bethell, R. W. Wicks, C. A. N. Hooper, H. H. Caddy, and M. T. Cowin, to *Glorious* (April 15).

Yorkshire Pageant Postponed

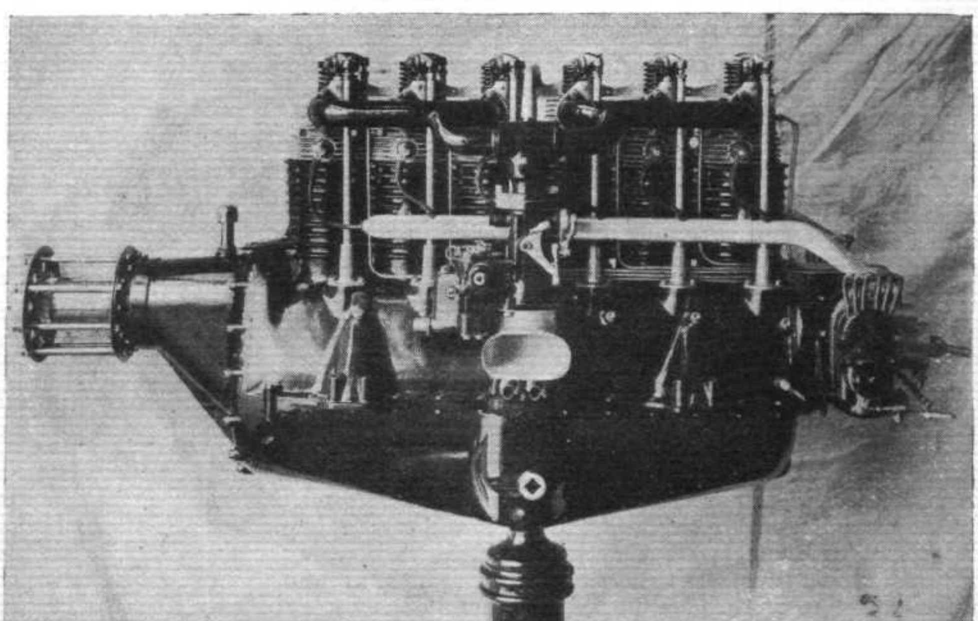
The Yorkshire Aero Club informs us that their Pageant at Leeds has been unavoidably postponed from April 26 to May 10.

Gipsy-Moth Price Reductions

The De Havilland Aircraft Co. announce a reduction in the prices of their Gipsy-Moths this week. This has been effected by standardising two models, and to a certain extent by cutting down on the extras allowed. The Standard Model in wood with the Gipsy 1 engine now costs £595, while the Special Model with a Gipsy II engine costs £750. Similar reductions have been made for either model as a seaplane.

A Leicestershire Gliding Club

The Leicestershire Glider Club has been established with headquarters at the Turkey Café, Granby Street, Leicester. The membership is steadily increasing, and several members of the Leicestershire Aero Club are interested. Mr. J. A. Hartopp has consented to be president, and he has granted the use of land at Bragdate for a flying field.



A GEARED SIX-CYLINDER AIR-COOLED ENGINE: The new Isotta Fraschini "Asso 80 R.I." has its cylinders cast "en bloc," and is fitted with a propeller reduction gear. The engine, which develops 100 h.p. at an airscrew speed of 1,200-1,400 r.p.m., is to be put on the British market. The weight is 151 kg. (332 lb.). (Flight *Photo.*)

IN PARLIAMENT

Air Forces (International Comparisons)

Sir S. Hoare asked the Under-Secretary of State for Air whether he will give the figures in percentages of increase or reduction of the Air estimates for the last five years in the United States of America, France, and Italy; the strengths in first-line machines for each of these years and the corresponding British figure; and any increase in the number of units projected by these countries in the Estimates of this year?

Mr. Montague: (1) The following table shows the approximate percentages of increase or reduction in air expenditure for the year 1930 as compared with the year 1925 in the case of Great Britain, the United States of America, France, and Italy:—Country and percentages of increase or reduction in air expenditure in 1930 as compared with 1925: Great Britain, per cent., − 2; U.S.A., + 140; France, + 114; Italy, + 31.

(2) Owing to differences in statistical methods and other factors, such as the fluctuations in strength which occur from time to time, it is difficult to supply strictly comparable figures for the numbers of first-line machines maintained by this country and the other countries specified for each of the last five years. The following table, however, gives the approximate figures, based on the latest official and other information available, in the years 1925 and 1930 respectively:—Great Britain, 630—780; France, 1,280—1,310; U.S.A., 750—950; Italy, 600—1,100.

(*Note.*—The figure of 1,100 for the Italian Air Force is understood to be a temporary excess over normal establishment, which is in the neighbourhood of 1,000.)

(3) The following new regular squadrons or equivalent units are likely to be formed during the current year:—Great Britain, 2 (corresponding number of first-line machines) 16; U.S.A., 4 (first-line) 24; France, 4½ (first-line 48; Italy, no information available.

(*Note.*—In addition, one non-regular squadron of 12 machines is to be formed in this country during 1930.)

※ ※ ※ ※

AIR MINISTRY NOTICES TO AIRMEN

Night Flying without Navigation Lights

1. During the period April 14 to September 7, 1930, and between the hours of 19.00 and 23.59, Royal Air Force aircraft will be operating in England by night in certain areas and under certain conditions which will be defined in subsequent Navigational warnings.

2. In view of the regular night services now operating between Croydon and the Continent, Royal Air Force aircraft taking part in the above-mentioned operations and flying within the area bounded on the north by the straight line Croydon–Deal–Belgium Coast, on the south by the straight line joining Croydon–Dungeness–French Coast, and on the east by the Belgian and French coasts between these lines, will always exhibit their navigation lights when flying below 5,000 ft. They may extinguish their navigation lights when flying above that height, but will always exhibit them when other aircraft are observed in their vicinity.

3. *Cancellation.*—N/A. Navigational Warning No. 7 of 1930 is hereby cancelled.

Navigational Warning (No. 9 of 1930).

Night Flying without Navigation Lights

1. With reference to N/A Navigational Warning No. 9 of 1930, Royal Air Force aircraft will, between the dates of April 14 and August 31, 1930, be operating by night within the area bounded by straight lines joining Reading–Stowmarket–Cranbrook–Alton–Kingsclere–Reading.

2. Except in so far as this area overlaps the civil air route area defined in paragraph 2 of N/A. Navigational Warning No. 9 of 1930, these aircraft may extinguish their lights above 3,000 ft., but when flying within the civil air route area, will not extinguish their lights except when flying above 5,000 ft.

Navigational Warning (No. 10 of 1930).

※ ※ ※ ※

MODELS

LOST AND FOUND

The following advertisement, which was inserted in certain newspapers, records a very interesting event in the history of model aeronautics:—" LOST.—Model Aeroplane; flown from Wimbledon Common, Sunday, March 30th, 12 o'clock; heading towards Southfields: finder rewarded." The model in question belonged to Mr. A. T. Willis, a member of the T.M.A.C., and, as reported in our issue of April 4, was launched in the ordinary way, when it rose to some 300 ft. and sailed out of sight; a member timed it for seven minutes before it was lost to view.

On April 4 a letter was received from the hon. secretary, Mr. H. Kirkham, of the Rawcester Athletic Association, at the sports ground (adjoining Southfields station) of the well-known manufacturers of Rawlplugs, which stated that if the advertiser would call at the sports ground the model which glided on to the courts on the Sunday morning (March 30) about 12 o'clock would be handed over!

The distance from the Windmill on Wimbledon Common to Southfields station is about 1¼ miles in a bee line, so Mr. Willis's model put up quite a nice little cross-country flight and has probably established a record. Mr. Rawbotham, who found the model, said it was a very interesting sight to see the graceful way in which the model came to earth—it was undamaged.

THE MODEL AIRCRAFT CLUB (T.M.A.C.)

The programme of competitions for the May meeting, at Wimbledon Common (near windmill) on Saturday, May 3, at 3.30 p.m., is as follows:—

Duration Competition, Fuselage Models (Light-weights).—Models weighing up to and including 8 oz. Ten seconds will be added to duration of models rising from the ground. *Prizes*: Agfa camera and two clocks will be awarded to three members whose models put up the best duration.

Duration Competition, Fuselage Models (Heavy-weight).—Models weighing over 8 oz. Ten seconds will be added to duration of models rising from the ground. *Prizes*: Three clocks will be awarded to three members whose models put up the best duration.

Duration Competition for any type of Model Aeroplane.—Three prizes will be awarded to three members (ladies and junior boys up to the age of 16 years) whose models put up the best duration.—Hon. Secretary, A. E. Jones, 48, Narcissus Road, Hampstead, N.W.6.

※ ※ ※ ※

PUBLICATIONS RECEIVED

Critica alla Spedizione Nobile. By Jotti da Badia Polesine. Libreria Aeronautica, Via S. Gregorio 36, Milan. Price L.10.

Concrete Aerodromes. The British Portland Cement Association, Ltd., 20, Dartmouth Street, London, S.W.1.

Welding Cast Iron. Suffolk Iron Foundry (1920), Ltd., Stowmarket.

Aeronautical Research Committee Reports and Memoranda: *No.* 1267. (*Ae.* 413).—Reduction of Drag of Radial Engines by the Attachment of Rings of Aerofoil Section, including Interference Experiments of an Allied Nature, with Some Further Applications. By H. C. H. Townend. July, 1929. Price 4*s.* net. *No.* 1273 (*Ae.* 419).—Experiments on an Ape Aeroplane Fitted with Pilot Planes. By S. Scott-Hall. May, 1929. Price 9*d.* net. H.M. Stationery Office, Kingsway, London, W.C.2.

※ ※ ※ ※

IMPORTS AND EXPORTS

Aeroplanes, airships, balloons and parts thereof (not shown separately before 1910).

For 1910 and 1911 figures see Flight for January 25, 1912.
For 1912 and 1913, see Flight for January 17, 1914.
For 1914, see Flight for January 15, 1915, and so on yearly, the figures for 1927 being given in Flight, January 17, 1930.

	Imports.		Exports.		Re-exports.	
	1929.	1930.	1929.	1930.	1929.	1930.
	£	£	£	£	£	£
Jan.	—	2	74,307	147,935	100	—
Feb.	6,532	2,460	195,369	226,049	2	1,000
Mar.	1,210	744	204,664	156,098	90	802
	10,594	6,191	474,340	530,082	192	1,802

※ ※ ※ ※

AERONAUTICAL PATENT SPECIFICATIONS

(*Abbreviations*: Cyl. = cylinder; i.c. = internal combustion; m. = motor. The numbers in brackets are those under which the Specifications will be printed and abridged, etc.)

APPLIED FOR IN 1928

Published April 24, 1930

30,310. C. B. Redrup. Lubrication of engines, etc. (327,113.)
38,328. Soc. d'Etude et de Construction d'Appareils de Tele-mecanique. Controlling aircraft. (303,365.)
38,346. C. B. Redrup. Means for converting reciprocating motion into rotary or vice versa. (327,161.)
38,419. E. Guillerot, J. Mivielle and H. J. Mevel. Propulsion of aeroplanes and boats. (303,181.)

APPLIED FOR IN 1929

Published April 24, 1930

498. Dicks Aeronautical Corporation. Screw propellers. (327,203.)
1,042 Cierva Autogiro Co., Ltd., and J. G. Weir. Aircraft with rotative wings. (327,211.)
14,633. Armstrong Siddeley Motors, Ltd., and S. M. Viale. Engine crankshafts. (327,316.)
17,432. A. Garelli. Starting devices for i.c. engines. (313,098.)

FLIGHT, *The Aircraft Engineer and Airships*

36, GREAT QUEEN STREET, KINGSWAY, W.C.2

**Telephone: Editorial, Holborn 1884;
Advertising, Holborn 3211.**

Telegraphic address: Truditur, Westcent, London.

SUBSCRIPTION RATES POST FREE

United Kingdom.	s. d.	United States.		Other Countries.*	s. d.
3 Months	7 7	3 Months	$2.6	3 Months	8 3
6 ,,	15 2	6 ,,	$4.12	6 ,,	16 6
12 ,,	30 4	12 ,,	$8.24	12 ,,	33 0

* *Foreign subscriptions must be remitted in British currency.*

Cheques and Post Office Orders should be made payable to the Proprietors of " Flight," 36, Great Queen Street, Kingsway, W.C.2, *and crossed Westminster Bank.*

Should any difficulty be experienced in procuring " Flight " *from local newsvendors intending readers can obtain each issue direct from the Publishing Office, by forwarding remittance as above.*